BACVLVM GEODÆTICVM, SIVE VIATICVM.

OR

The Geodeticall Staffe,

Containing eight Bookes:

The Contents whereof followe after the Epiſtles.

Newly deuiſed, practiſed, and, publiſhed by *Arthur Hopton* Gentleman.

AT LONDON,
Printed by *Nicholas Okes* for Simon
Waterſon, dwelling at the ſigne of the
Crowne in S. Pauls Church-
yard. 1610.

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BRITISH MUSEUM

TO THE RIGHT HONOVRABLE, ROBERT EARLE OF SALISBVRY,

KNIGHT OF THE MOST HONORABLE ORDER OF THE GARTER, VIScount Cranborne, Lord Cecill of Eſingdon, Lord high
Treaſurer of England, &c. Maiſter of his Maieſties court of Wards and Liueries, Chancellor of the Vniuerſity of Cambridge,
*and one of his Maieſties
moſt Honorable priuy
Councell.*

NO man right Honorable, findeth a precious ſtone, bearing the ſplendor of any rich margarite, but ſtraight haſteth vnto the beſt lapidiſte, whoſe happy allowance thereof begetteth a rare affectation, and ineſtimable valew of the gem : ſo ſtandeth it with your Honour, the curious Lapidiſte of our moſt excellent wits, to whoſe touch euery refined tong offereth the quinteſſence of his beſt inuentions. And therefore ſome, whoſe induſtries haue laboured in the treaſury of Diuinity, ſome in the neceſſity of humanity, ſome in the delectation of the Politicks, ſome in the affectation of the Oeconomicks, ſome in Philoſophy, others in Poetry, haue all brought the depth of their golden ſtudies, to bide the touch of your noble allowance: ſo that after-ages may rightly admire what noble Mecœnas it was that ſo inchayned the aſpiring wits of this vnderſtanding age to his only cenſure, which will not a little magnoperate the ſplendor of your well knowne Honour, to theſe ſucceeding times. Which ſeeing, & hauing found this ſparke of the Mathematicks, neuer yet ſeene before, am bold to craue your noble approbation, that it may goe (though vnworthy) amongſt the reſt of thoſe worthy Iewels, that already haue paſt the proofe of your ſingular iudgmēt: So ſhall we haue great hope, that the radiant beames of your reſplendent wiſdome, fauorably ſhining a little hereon, in ſhort time wil reuiue the Mathematicks (the Phœnix of Arts) from the aſhes of obliuion, that they may ſit in this kingdome amongſt the ſweet inuentions of the age, and in our owne language ſing forth the eternall glory of learning, as well as in other nations it doth. Euery Muſe (noble patron of vertue) hath long ſince found a double-topped Pernaſſus in England to ſolace vpon, ſaue onely Vrania; euery Muſe hath her delicious Helicon to ſport in, ſaue only Vrania; euery muſe hath ſipt of the ſweet Nectar, ſaue onely Vrania. Erato hath wonne a crowne, Vrania wants a garland: then let me humbly implore your Honour, graciouſly to protect the fruits of this eſtranged Muſe vnder the ſhadow of the ſweete branches of your neuer decaying glory, which is all-ſufficient to infatuate and annihilate each viperous malediction of the enuious Pierides. I know there be bookes extant treating of the art of meaſuring ground of, which a part of this booke alſo conſiſteth; but they be lame and defectiue, euen as a number of our ſurueyors be, that thruſt themſelues into buſineſſes without ability to performe: wherefore I haue endeauored (my good Lord) as well to redreſſe wants in the one, as repleniſh art in the other, not doubting (ſeeing it becomes ſo requiſite & neceſſary a faculty) but to make the ſerious ſtudent able hereby to benefite his country and common wealth very much.

Laſtly (to ceaſe troubling your Honour) if the dedication of bookes in any part may giue acknowledgement to great men for peculiar fauors and many ſingular graces ſhewen, then doth duty bind me obſequiouſly to remunerate your honorable fathers reſpect of our name and poore family, to whom my anceſtors were, (and of a neceſſary conſequence, my ſelfe to your Honour am) euer obliged. And vpon that foundation I builded the hopes of this preſumption, which if it proue firme, ſhall animate me hereafter, to aime to reach in ſome higher ſtraine the Diateſſaron of your memorable vertues. Thus in ſeruice at command, in duty bound, and in prayer continuall to the Almighty for your good Honour, I end, reſting

In all humble duty at your
Honours commaund,

ARTHVR HOPTON.

To the beneuolent Reader.

THe opinions be manifold, and the inſtruments multitudes, gentill Reader, that the diuerſity of pregnant wits haue brought forth in this age, and euery of thoſe inſtruments ſerue for ſome ſingular concluſions; but I happely finding the contriuing of an inſtrument not bound to any particulars, but free, apt and generall, ſo that he is moſt fit to worke, moſt facill in working, and moſt eaſy to cary; out of my loue to thoſe that long after theſe arts, I could doe no leſſe then commit it vnto their reading, hoping as my intent was to benefite them with my labours, ſo likewiſe they will graint a fauorable vouchſafe to requite my paines, and that is all I ſeeke; which finding, I will anſwere then that this booke ſhall teach them to ſeeke dimenſions, both Aſtronomicall and Geometricall, to platte and meaſure grounds, both Arithmeticall and Mechanicall, in ſuch a compendious method, that the vnlearned neuer trained in the ſtudies of theſe artes before, may with admiration accompliſh thoſe things that learned men haue paſſed ouer the moety of their liues to find out. And if this inſtrument pleaſe you not, you may turne further, and looke vpon the Topographical glaſſe, *an inſtrument no leſſe ſingular and commendable then the former, and for your practiſe whereon I haue ſet downe many* Topographicall *and* Geodeticall *concluſions, which becauſe I aime to ſute you with varieteis, behold the vſe of the Theodelitus, the circumferentor, with a reformation of the plaine Table, comprehended all vnder the title of the* Topographicall glaſſe.

And ſince euery one that writeth a booke of any materiall conſequence, diſputeth firſt, and ſhewes what neceſſary commodity may accrew to the reader, leſt other wiſe it be held impertinent and nothing commodious for the common wealth, (the aduancement whereof, all men are bound in Chriſtianity to tender;) it ſhall therefore nothing diſtaſte, briefly to remember the ſame. Firſt then enqure of the Souldier, a chiefe defendant of his country, if he be not taught hereby to diſpoſe of plats, caſtles, forts, citties, and ſuch like, to appoint places conuenient for the sampe, & to proportion euery part according to the number of men and horſe: let the Politician ſpeake of proportions, and allowances, let Architectors ſpeake of plattes and ſymmetries, let the the pioners ſpeake of conducting mines and vaults vnder the earth, for the blowing vp of citties, forts and caſtles; let the Nauagators ſpeake of true directions in the vnknowen path of the ſeas, yea let all men ſpeake of what vocation ſoeuer, and they ſhall find diuerſity of matter, as well to exerciſe the head, as recreate the wit. Amongſt many, I will ſhut vp this argument with the Geodetor or meaſurer of land, whoſe antiquity is great, as we may perceiue by Zachary, *Chap. 2, queſtioning with a man that was meating* Ieruſalem; *and whoſe commodity is no leſſe great then ancient, as may appeare by the exundation of* Nilus *in* Ægipt: *for when al the bounds and limits of euery ſeuerall mans particular was drowned and buried in the ſlime and mudde remaining after the recourſe of the floud, by the true direction of this ſcience, euery man was allotted his proper quantity of ground in the ſame proportion it was before. Then let none grudge if we teach them the myſtery and hid ſecrets of ſo neceſſary and rare an art, ſo beneficiall for man and ſo requiſite in a common wealth, ſo conuenient to be knowen of ſome, and expedient to be credited of al, teaching nothing but truth and certainties, approued by inuincible grounds of infallible Geometricall demonſtrations; and therefore we will not ſtagger to inſerte it, as an aſſociate to iuſtice, one of the foure cardinall vertues, whoſe office, as* Ambroſe *ſaith,* 1 de Officiis: Quæ nihil alienum vendicat, quæ cui.

libet

bet dat, quod ſuum eſt, quæ negligit propriam vtilitatem, vt ſeruet communem æquitatem: Et ſecundum ipſum, prima iuſticia in Deum, ſecunda in patriam, tertia in parentes, quarta in omnes. *For what elſe doth this art of Geodetia but teach directly* cuilibet dare quod ſuum eſt, *to giue euery man his owne, as well the Lord as the tenant, as well the buyer as the ſeller, as well one man as another: it brookes no deceit in exchange, no oppreſſion of the poore, no wrong to the Lord, but aimes in all points to giue euery man his owne: & therfore the office of a iuſt & ſkilfull Geodetes is a perfect glaſſe, wherein as a true mirrour we may behold a number of other vertues, although ſome will ſay they be bad members grown (in this as all other faculties) ſome be, ſhall a particular ſubuert the generall?* A particulari ad generale non eſt tenenda ratio: *for we meane none of thoſe that in baſe bils like players, paſted vpon poſtes, impudently affirme they will ſuruey any Manour, and find it more then formerly it was ſurueyed to be; ſuch paltry bils I ſaw my ſelfe in London ſome three or foure yeares ſince, much diſgracing the arte: for either they muſt affirme they may lye by arte, or elſe can enlarge the true bounds of the Manour by arte. But the firſt platte being truly taken, this aßertion muſt needs be falſe: but I [illegible] no more blame them to auouch this in their bils, (being they are to be condemned for the paſting of them vpon euery poſt) ſhall we now turne the Mathematicks a begging? where is Alphonſus, Ariſtarchus,* Archimides, *or ſome of the noble profeſſors of this ſkill? it is time to make the painters carue their tables, and take the Globe out of the king Ptolomies hand, and there place a poore Squire, ſuch as [illegible] vſe to hang vp in a* Church. *We call the Mathematickes the liberall ſciences, becauſe they ſhould be freely taught, as I thinke they be moſt fit to be ſtudied by great men, that haue large purſes & fine wits; for indeed theſe kind of artes be chargeable and difficult. But now forſooth he that can but get an old plaine Table, and meaſure a meadow (how ill ſoeuer) is a* Geometritian, *though by profeſſion a homely Carpenter or rude*

Maſon, and he that can but find the ordinary place of a planet in an Ephemerides, *is an* Aſtronomer, *though otherwiſe a poore tradeſman, of wit ſcarce enough to get his owne liuing: thus is art troden downe with preſumption, and the world poſſeſt with errours. I haue heard diuers aſſertions and childiſh aſſumptions of ſuch artleſſe fellowes, though my ſelfe being unknowen to them; ſome will produce you a pretty ſmall brazen inſtrument forth of their pocket; and will affirme with that to goe into the middeſt of any field, and preſently tell how many acres be in the ſame before he ſtirre, neither will he uſe the helpe of any cheine: which is nothing but meere fooliſh ſurmiſes and rude preſumption, as farre out of their ability to performe, as they are from the underſtanding of the art, poſſeſſing the world with impoſſibilities and boſting affirmations. I confeſſe by Art ſuch a thing may be performed, ſo the medowe be plaine, and of a ſmall quantity, but is not to be ſpoken in a generality, or as a neceſſary or ſpeedy concluſion.*

Now ſome there are that will abruptly ſay this ſurueying maketh the poore Tenants haue hard bargaines, whereby all things grow ſcarce and deare. I anſwer, no: In what part of iuſtice is it that the Lord ſhould be ignorant of his owne? doth his knowledge abridge his conſcience? how then is ignorance the mother of tranſgreſſion? is it not ſeene that many men of good conſcience by ouer eſtimating their lands, let their Tenants more then hard peniworths? the randon is no ſcantell: can the tradeſman ſet his friend a reaſonable price of his merchandize, when he is both ignorant of the quantity and quality of the commodity he ſelleth, when as he knoweth both the uſing of his friend reſteth in the goodneſſe of his conſcience; ſo is it with the Lord and Tenant; and that the meaſuring of ground ſhould bring dearth, is as falſe as the former: For if the tenant will couenant with the Lord, that he ſhall haue all commodities at the price they were in yeares paſt, the Lord will likewiſe promiſe the Tenant the like rate of his lands; but if all things grow to a farre higher rate then formerly they were, ſhall onely land be bound to reſt at the old ſtint: ſhall euery *tradeſmen inhaunce the prizes of their wares, and onely the reuenews of gentlemen be rated? muſt euery one haue free liberty to make the beſt of his owne, and onely Landlords apportioned? It is a peeuiſh obſeruation and fooliſh lenity ſo to doe, & is a principall cauſe wherfore ſo many tradeſmen creepe into the ancient poſſeſſions of Gentlemen; yet notwithſtanding it is moſt requiſite that the Lord vſe a fauorable improuement; for ſo to doe is acceptable before God and man: and therefore the Geodetor ought to yeeld a conſcionable & true information to the Lord. But gentill Reader to conclude, let ſparing reproofe aſſure me of kind acceptance, and then haply I ſhall be induced the rather to publiſh the flowers of the* Mathematicks, *not yet finiſhed, with another inſtrument called* Clauis Mathematica *or the key of the* Mathematicks; *for that it unlocketh as it were all* Mathematicall *queſtions, laying them in a plaine method open, unto thy view; the meane time I reſt ready to doe thee any fauour I may,*

Arthur Hopton.

Ioannes

Ioannes Paſſy in Artibus Magiſter, in laudes huius operis.

Stemmata quid proſunt, ſeriem referentia longam?
    Quid genus antiquum nobilitate potens?
Si non quæ ſcriptis ornet ſtirpem generoſam,
    Virtuteſque virum, dextera docta foret?
Eſt domus Hoptoni (fateor) per ſæcula durans,
    Virtute exultans, & ſine tabe virens:
Quæ nunc Arthuri vigili decorata labore
    Emicat, & florens tollit ad aſtra caput.
Agricolæ, Mercatores, Nautæ, Medicique,
    Et genus omne hominum ſedulitate tua
Debebunt Arthure tibi, dum voluitur axis
    Æthereus, dum Sol ſplendet, & aſtra micant.
Deſine liuor edax benefacta reprendere dictis,
    Et bene promeritis gloria digna ſonet.
Ingenium Phœbus, Pallas tibi contulit artes,
    Iuno decus, laudes vita polita dedit.
Arthure ô fœlix viuas ter Neſtoris annos,
    Accedat laudi viuida fama tuæ.

I. P. Mag. artium, in laudem huius operis Arthuri Hoptoni Generoſi

QVi legis Hoptoni perſcriptum nomine librum,
    Perlege ſinceré, conſulitoque boni,
Multa fauente Deo, permulta volumina poſthac,
    Confecturus erit, dummodo vita ſinat.

In Laudem M. Arthuri Hoptoni Mathematici.

VVake gentle Muſe and giue me leaue a ſpace,
    Inſpire my wit with thy all-quickning grace:
Direct my pen to paint forth Hoptons name,
    whoſe merits doe deſerue immortall fame.

Immortall fame and honor of our time,
 Whoſe kinde endeauours doe our art refine:
Teaching proportion Miſtris of each art,
 Vpon the ſtage to act an vnknowne part.
An vnknowne part, for neuer did I heare,
 That Stagerite in arts high Theatere,
Breathing darke grounds from aphoriſmes ſtrange,
 Could acte a ſcene, ſo frought with pleaſing change.
Thou rareſt man, and more then Englands pride,
 Haſt brought to paſſe what art before denide:
Hold on thy courſe, for euer ſhalt thou liue:
 Thy bodies death, life to thy vertues giue.

G. Giff. Gen.

Rogerus Stedmanus Capellanus reuerendi in Chriſto patris, Roberti permiſſione diuina Hereford. Epiſcopi, & publicus prædicator, in laudem authoris & ſingularis induſtriæ ſuæ.

QVod domus Hoptoni, multis durauerit annis,
 longæui recolunt tempora longa ſenes.
Cognita præclaram referunt inſignia laudem:
 antiquam reſonant inclyta facta Domum.
Hoptoni de Hopton vigeat celeberrima fama,
 Arthuri, ac feriat ſydera clara poli:
Laus ſua iuſtitia celebratur digna fideli,
 digna quidem meritis, dignaque fama fide.
Eſt iuuenis vultu: diuino Pallas ab ore
 profluit, & meritis inclyta fama venit.
Sydera deſcribit notis diſtincta figuris:
 dumliquidis lymphis aurea luna nitet,
Arthurus numeris numerabit tempora certis:
 ordine cantabit ſydera celſa ſuo.
Splendida perluſtrat ſupremæ ſydera ſphæræ,
 ſomnigenis tribuens lumina magna viris.
Denique ſancte Pater, ſpecialem mitte fauorem,
 vt faueat cœptis candida muſa ſuis.
Cœleſtique libro ſcribatur vita beata:
 inter & electos numina ſancta choros
Proſpera cuncta precor, ſibi ſint fœlicibus annis,
 poſtque ſuam mortem non peritura ſalus:

To

To Maiſter Arthur Hopton.

Pythagoras in teaching did maintaine,
When bodies di'de, their ſoules returnd againe,
And kept the minds that they were vſ'de to doe,
Within thoſe bodies they did run into:
And now I ſee his maxim true and iuſt,
Hath ben too long abuſed by the moſt:
For who ſhall with Iudicial eye ore-looke
The curious art compoſed in this Booke,
Cannot deny in Hopton to ariſe,
The ſoule of great Archimedes the wiſe.
Sweete Arthur, well deſeru'ſt that princely name,
Which from the regall conſtellation came,
Arcturus bright, which in himſelfe containes,
The very nature that in thee remaines.
And doubtleſſe at thy bleſſed birth ſo ſhone,
That all the ſtarres were dimd by him alone,
Whilſt he about the Northen pole did glide,
As Lord cōmander of the heauens wide,
Diſtilling downe vpon thee without ſpare,
Ioues diuine nature and the God of warre:
As thou by wiſdome mighſt thy fame maintaine,
So well as with the honour of thy name,
Which hath ben long and ancient without doubt,
Witneſſe the houſe from whence thou cameſt out,
And from whence each beſt Hopton of old time
By law of armes ought to deriue their line.
Then what apt ornament is't I might chuſe
To feed the height of thy aſpiring muſe?
A crowne of bayes for Poets, not for thee,
Thy Temples ſcorne to beare Apollos tree:
A weath of ſtarres, robes of immortall fame,
ſhall girte thy browes, ſhall clothe thy loued name.

I. M. Gen.

The

The contents of each ſeuerall Booke.

1 The firſt declares the compoſition, conſtruction & definition of the Staffe, with certaine neceſſary Tables and propoſitions to be foreknowne.

2 The ſecond containes the quantity of all meaſures both Engliſh and other, with Tables of the ſame, to ſeeke all kind of angles and their ſides, & thereby to find all dimenſions, as longitudes, latitudes, altitudes, and profundities with the ground thereof, alſo to worke as M. D. Hoods ſector &c.

3 In the third Booke is ſet downe the vſe of the hypſometricall ſcale, according to the doctrine of the beſt writers in that behalfe, to which is added many other propoſitions performed by glaſſes, &c.

4 In the fourth, is the large vſe of the Geometricall Quadrant.

5 In the fifth, the vſe of the *Iacobs* ſtaffe with the making of a new kind of ſcale, and thereby to worke the rule of proportion, called the golden rule or rule of three, and to worke the ſame rule inuerſed.

6 The ſixt containes the art of Geodetia, or meaſuring of grounds, which is deuided into two parts, in the firſt you be taught to ſeeke the true proportion and ſymmetry of grounds, according as it lieth without the dores, with rules to know if you haue wrought true or falſe; alſo to reduce the hypothenuſall lines to lines Horizontall, and to protract after a new order, reforming many errours formerly practiſed in platting grounds.

The ſecond part doth teach you how to know the contents of any peece of ground how irregular ſoeuer, with Tables diligently calculated to auoid Arithmetick, as well to know the exact contents as to deuide or ſeparate land, with rules to performe the ſame inſtrumentally, alſo to meaſure ſolids as ſtone, timber, &c. or ſuperficies as boords, glaſſe, &c. with M. *Digges* his Tables for that purpoſe; to ſeeke all kind of dimenſions by protracting, the rare metamorphoſing of all kind of figures, and finding of their proportions one to the other, with the theoricall ground of all theſe; alſo to make a Lord of a Mannour to expreſſe each ſeuerall Tenure, &c. newly & compendiouſly, with certaine notes requiſite for all Geodetors to know, &c.

7 The ſeauenth containes Trigonometria or the doctrine of right lined tryangles, by Sines, Tangents, and Secants, with new Tables.

8 The eight, containes the vſe of the ſpheare in plano, with the making of many kind of Dials onely by the ſtaffe.

There is an other Booke called the Topographicall glaſſe yet to come forth, containing the large vſe of the Theodelitus, Topographicall inſtrument, circumferentor, and plaine Table; teaching you alſo to deſcribe countries, and to find the howre of the day and night, to know the altitude of the Sunne or any ſtarre after a new order, alſo to make a new kind of plaine, and to take a ſuruey after another order, all which you may better ſee in the generall Table.

The

The Printer to the Reader.

For errours paſt, or faults that ſcaped be,
Let this collection giue content to thee:
A worke of art, the grounds to vs vnknowne,
May cauſe vs erre, though all our ſkill be ſhowne.
When points and letters, doe containe the ſence,
The wiſe may halt, yet doe no great offence:
Then pardon here, ſuch faults that do befall,
The next edition makes amends for all.

Errata.

Pag 3 line 26. for graduator read graduation, p. 7 l. 17. for pleaſe the, r. pleaſe of the, p. 8 l. 6. 8 for D r. R; p. 9 l. 18 for 4 read D, p. 9 l. 26 for Q N r. Q W, p. 10 l. 5 for B r. O, p. 11 l. 23 for deriuation, r. graduation, p. 11 l. 4 for the deſcription r. the end of the deſcription, p. 14 l. 12 for other of r. to the kind of, p. 17 l. 19 for adumbrat r. abumbrat, p. 18. li. 12. for equall read equat, p. 18 l. 29 for other where r. otherwiſe p. 18 l. 40 for Iacob and r. Iacobs ſtaffe and, p. 23 l. 3 for ſpoked r. ſpoken, p. 24 l. 3 for foode r. foote, p. 37 l. 11 for vntill the point r. till he point, p. 37 l. 7 for let N A B, r. let A B, p. 41 l. 9 for all r. alwaies, p. 50 l. 21 for eight r. right, p. 56 l. 17 for I take, r. muſt be out, p. 64 l. 4 for 27 r. 28 p. 72 l. 1 for A C K r. A I K, p. 87 l. 7 for A H r. H I, p. 92 l. 14 for S K F r. S K P, p. 91 l. 15 for A C r. A one, p. 97 l. 22 for 4 ins r. 4 times 5, p. 99 l. 30 for G D r. G E, p. 99 l. 34 for of the I R r. of I K, p. 100 l. 24 for proportionall 80 r. Proportion rearmes, p. 102 l. 19 for the ſill r. the ſight, p. 104 l. 5 for tranſuerſing r. tranſuerſary, p. 107 l. 32 for right as the, r. as the ſegment of the index ſhall be to the, p. 112 l. 18 for as B D r. as B E, p. 115 l. 9 for of degrees r. of 39 degrees, p. 121 l. 18 for then B G C r. then B I C, p. 122 l. 20 for A M r. A N, p. 123 l. 1 for compaſſe E r. compaſſe in E, p. 124 l. 30 for you are r. that are, p. 128 l. 26 for C B C B r. A B A B, p. 131 l. 4 for ſeeme curious r. ſeeme to curious, p. 133 l. 25 for anſwered r. allured, p. 143 l. 12 for the chapter r. the laſt chapter, p. 149 l. 14 for compoſe halfe r. compoſed halfe, p. 151 l. 12 for Iſophiron r. Iſopleuron, p. 171 l. 3 for oppoſite r. propoſed, p. 171 l. 4 for a trapezia r. Iſoſceles trapezia, p. 171 l. 20 for leſſer r. greater, p. 172 l. 26 for halfe three degrees r. halfe third part, p. 215 l. 17 for C towards D r. H towards G, p. 216 l. 18 for C D and vpon D r. H G vpon G, p. 216 l. 19 r. then vpon H of 6 degrees as F H E, then note &c. p. 217 l. 8 for 31 chap r. 29 chap, p. 218 l. 18 for as L F I r. as I P R, p. 222 l. 39 for B F K H r. B I K H, p. 224 l. 3 for E C F B r. E C F A, p. 229 l. 1 for D I r. D I, p. 239 l. 6 for too taker r. take, p. 252 l. 27 for omitted r. committed, p. 257 l. 22 for taking r. laking, p. 258 l. 16 for chargeth r. cheriſheth, p. 260 l. 2 for the ſide r. the ſite, p. 263 l. 25 for but tooke r. but take, p. 276 l. 21 for lines r. ſines, p. 285 l. 31 for F N r. F M, p. 285 l. 6 for B E be equall, r. D E be parallel, ibid. l. 7 for P 29 r. P 30, p. 297 l. 1 for Regiomontan r. Regiomontanus, p. 298 l. 11 for G F r. G E, p. 299 l. 39 for finding r. find, p. 335 l. 1 for E K r. L K, p. 336 l. 1 for by the 20 degree of ♉ r. for the 20 degree of ♊, p. 336 l. 15 for M r. m, p. 337 l. 1 for to I r. to S, Ibid. Ibid. for B I r. B S, p. 339 l. 8 for parts r. poles, p. 339 l. 14 for I L r. K L, Ibid. l. 30 for ☉ degree ♎ r. 0 degree ♏, p. 314 l. 21 for 8 degrees r. 18 degrees p. 361 l. 19 for on L r. on B, p. 363 l. 2 for and in any r. in any, p. 363 l. 5 for F E G K r. G E I, p. 363 l. 7 for E F r. E I, p. 365 l. 17 for declinaton r. declination.

Scheames or figures miſplaced or omitted.

Fol. 55 l. 17 ſcheame in the 22 Chap. fol. 93 chap 17 ſcheame in the chap. 7 l. 4 fol. 151 pro 2 place the figure in the 3 pro. fol. 151 pro. 3 place the ſcheame in the 2. pro. fol. 165 ſcheame in the 24 chap. fol. 31. 7 chap. 21 the figure in the chap 17 fol. 360 ſcheame in the 337 fol.

Faults by the cutter.

Theſe faults be ſomething generall and not well to be reformed by the Printer, as in the ſecond booke there is many pictures of Caſtles, Trees, &c. omitted in diuers ſcheames and there and elſe where, ſome letters omitted and others miſtaken, which the diſcreet reader will beſt correct.

The

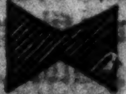
THE FIRST BOOKE OF THE GEODETICAL STAFFE, SHEWING THE COMPOSITION and making, with the diffinition and explication thereof, and euery thing therein contained, with their vocables: alſo certaine Tables and propoſitions, neceſſary to be firſt knowne.

Chap. I.

Of the framing, compoſing, and quantity of mettall or wood required to make the Geodeticall ſtaffe.

TO ſet a part all circumſtances in ſpeech whatſoeuer, you ſhall therefore firſt prepare two rulers or neate peeces of ſiluer, bone, braſſe or wood, which you pleaſe. Being wood, let it be ſuch ẏ is firme, ſolid, and of a cloſe graine, wel plained and truly tryed to 3. quarters of an inch broad, & a quarter and halfe quarter thicke, in each of theſe rulers muſt be two hollow chanels, Rabboth, or Tranſumes, as Carpẽters call thẽ, they muſt be vnder hollowed doue-taile wiſe, ſo that the two hollowed ſides beeing turned together, there may be a concauity or hollowneſſe of a quarter of an inch ſquare, repreſenting this figure.

What ſtuffe the ſtaffe is of.



2 Then muſt you prouide a Ruler of like wood or ſtuffe, made ſeite and equall to runne into the foreſaid hollow chanell, ſo that the two hollow ſides being turned together, and the Ruler put thereinto, the legs cannot bee opened by reaſon of the doue taile chanels.

The graduator.

3 Next muſt you ioyne theſe two rulers (which beare the hollow chanels) together, as you doe the Sector or Circular Scale, or ſuch kinde of Inſtruments, and the Center pin that ioynes them

The center pin.

The Center pin.

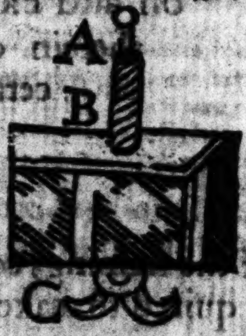
muſt be hollowe, ſufficient to containe a ſtrong ſcrew pin, neither is it materiall whether theſe two rulers ſo ioyned together be left ſquare, or made round.

The Courſer,

4. This ſo contriued, there muſt be a Courſer prepared, as B, which is a hollow ſocket of braſſe made fit and plyant to moue along one of the rulers lately ioyned together, upon the top of which Courſer anſwering to the fiduciall edge of the Ruler muſt ſtrongly be fixt a ſcrew pin better then an inch long, as B A, ſo that this pin is allwaies moued iuſt ouer the fiduciall edge of the Ruler.

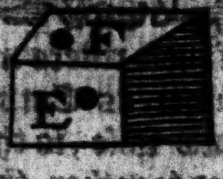
The Courſer for ſquare legges.

If this Courſer bee made halfe round for the round legs, or ſquare, for ſquare legs: yet muſt it be cut ful of holes, to the end to ſee the figures upon ẏ legs through ẏ ſame, as you may perceiue by the figure. In the lower ſide, this courſer muſt be placed a ſcrew pin, as C to faſten ẏ courſer at any place aſſigned, ẇ a thin plate of braſſe (as ẏ order is) within ẏ ſaid ſocket, for ẏ ſaid ſcrew pin to force againſt ẏ ruler.



The ſquare peeces of braſſe.

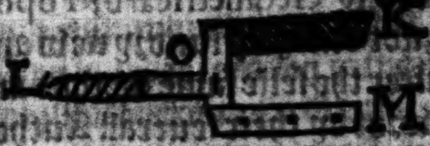
5. Next muſt you haue a little ſquare peece of braſſe, the thickneſſe of which muſt be equall to the thickneſſe of the third ruler or graduator: through the peece muſt be bored a hole, as F, equall unto the bigneſſe of the ſcrew pin A, ſo that the ſaid peece may ſlip downe unto the foote of the pin B, then through the fore ſide of this peece of braſſe muſt bee bored another great hole, on the bignes of a large wheaten ſtraw, as E, the centers of which holes F and E muſt be ſo farre ſidewiſe one off the other, as halfe the thickneſſe of the Graduator E, ſtanding equall betwixt the upper & lower ſide of the peece of braſſe, as in this figure: When theſe holes be bored, you may file much of the ſuperfluous braſſe away, prouided that it retaine the foreſaid thickneſſe.



The pin at the graduators end.

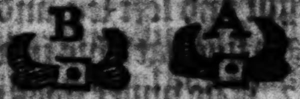
6. Next unto this muſt be faſtened at the end of the third rule, a pin of braſſe, equally to moue in the hole E, in the laſt figure. This pin at the one end muſt haue a ſcrew for the peece of braſſe A, in the 7. figure to ſcrew on the back ſide, beeing put thorough the hole E in the 5. figure, to the end he may not ſlip out of the foreſaid hole, but be faſtened by helpe of the ſcrew, the pin is L O, and to the end C muſt be firmely faſtened or filed two lippets or cheekes of Braſſe, K & M, to riuet the ſaid pin faſt unto the graduator or third ruler, which being artificially made, it

will repreſent this figure.



The ſcrew peece of braſſe.

7 Next muſt you prouide two neat peeces of braſſe, with ſcrew holes therein, iuſtly to fit the ſcrew pin A B in the 2. figure, and L O before deſcribed, ſo that the hole F in the 3. figure being put on the pin A, and downe to the foote thereof at B, this ſaid ſcrew peece B being turned downe hard, and wreſted thereunto, may ſtay ẏ peece of braſſe, that he cannot mooue any way: they would be made in maner of the ſcrew peece in ẏ deuiding compaſſe, repreſenting theſe figures.



8 The ſixt figure muſt be ſo contriued, that whether you turne the ſide K or M, they may either anſwere to the middeſt of the pin A B, ſo that which ſide the graduator ſoeuer be turned thereunto, the fiduciall edge thereof may alwaies agree with the center of the ſaid pin, the hole F being put on the pin A B, and the pin L O being put through E in the 5. figure.

9 Next muſt you prepare a ſtaffe 4. foote in length, he muſt be bored hollow 2. foote and a halfe deepe, that the foreſaid 3. rules being put together, they may be all three likewiſe put into the ſaid hollow ſtaffe, and then you muſt haue a fine top to goe on with a ſcrew in maner of an Aqua vitæ bottell, ſo the ſtaffe being made round taper wiſe, and ſmall to carry with eaſe, the ioyners worke thereof is finiſhed. Then proceede vnto the graduator thereof: but becauſe you ſhall be acquainted with the names and parts of the ſtaffe thus ſet together, I will firſt ſhew you the definition and vocation thereof.

The hollow ſtaffe.

CHAP. II.

Of the Definition, vocation or nomination of the Geodeticall ſtaffe, and his principall parts.

BEfore wee proceede vnto the diuiſions & pricking of circles and ſuch like vpon the Geodeticall ſtaffe, we will firſt lay open the ſeuerall parts thereof: if any man therefore demaund what this Inſtrument is, it may be anſwered, that it is an Iſoſceles Tryangle of two equall containing ſides, coupled together in maner of a Sector, which doe open & cloſe as an ordinary paire of compaſſes, euery degree or part therin contained, or imagined is ſo proportionally, congruently and artificially proiected thereon, that it performeth and containeth in dimention, the whole vſe of any Geometrical or Topographical Inſtrument whatſoeuer, not onely by ſundry new and rare waies of himſelfe: but alſo after the ſelfe ſame method and forme, as thoſe inſtruments are wrot by their ſeuerall Authors, for the Appellations of this inſtrument, hauing ſhewed you that it is a Tryangle, the reſt followes.

The legges.

1 The two ſides of this Tryangle are diſtinguiſhed by the right and left leg, and each leg hath his vpper and lower ſide, and each ſide hath his inward and outward ſide.

The vpper ſide of the legges.

2 The vpper ſides of theſe two legs, inward & outward, beare equall diuiſions, & are numbred by 5.10.15.20.&c. from the Center towards each end, on the outer ſide onely.

The ſites.

3 In each leg is placed an equicurral ſight, and to the ſight in the left leg is fixed the end of the graduator, theſe ſights ſerue to direct the legs vnto any marke aſſigned.

4 In each leg is a line drawne round about the ſame, & where this line and the fiduciall edge of the legs interſect, there is a point called the point Reſpectiue: becauſe without reſpect vnto this point, the quantity of no angle can be expreſſed: therefore you muſt haue a ſpeciall regard thereunto.

Point reſpectiue.

Lower ſide of the legs.

5 Upon the lower ſide inward of this inſtrument are ſet vnequall deuiſions, onely vpon the right leg (as in the 4. pro. they be numbred) from the point reſpectiue towards the center by 5. as 95.100.105.110.&c. and ſerue to expreſſe the quantity of an Angle aboue 90. degrees, ſee more Pro. 7.

The Graduator.

6 To this Inſtrument alſo there belongeth a rule 4. ſquare hollow on two of his ſides, as in yͤ 1. propoſitiō. This rule is called the graduator, becauſe of the manifold diuiſions proiected thereupon, he is ſo faſtened vnto the ſight in the left leg, that by helpe of a ſcrew, & ſcrew pin he may be fixed at any angle giuen, and yet will moue, ſo that you may turne any ſide downewards you pleaſe, ſo that he admitteth a triple motion: Upon this graduator are proiected 4. maner of Diuiſions.

Pro. 4.

Degrees of a Circle.

7 Firſt are placed the degrees of a circle to 90. numbred from the end where the braſſe pin is, towards the other end by 5, as 5. 10. 15. &c. and ſerue to expreſſe the quantity of any angle vnder 90. degrees.

Equall parts of the Graduator.

8 Secondly, are placed equall deuiſions numbred as the degrees of a circle, and ſerue to expreſſe the ſides of any Tryangle giuen,

uen, and are placed in the hollow ſide of the graduator, the equall parts are ſuch as be placed vpon the vpper ſide of either legs.

Parts of the Geometricall Quadrant.

9 Thirdly, are placed the part of the Geometricall quadrant, proiected on the graduator, and are numbred from either end thereof towards the middeſt by 5, as 5.10.&c. ending in the middeſt at 60. they ſtand oppoſite vnto the degrees of a Circle.

Part of the Hypſometrical Scale.

10 Fourthly, are placed the parts of the Hypſometricall Scale, in the hollow ſide oppoſite vnto the equall deuiſions, numbred vpon the Graduator from either end towards the middeſt by 3, as 3.6.9. ending at 12. in the middeſt. Through the center of ỹ 2. legs, there is a hole called the Center of the Inſtrument, thorough which hole is a braſſe pin to be thruſt, called the Center pin, three inches long, as in the 7. pro. at this letter W.

The center of the Inſtrumẽt.

The ſcrew pin that faſtens the graduator vnto the left leg, is called the Center of the graduator.

The center of the graduator

In the right leg of this inſtrument, muſt be a little moueable ſight to run in the hollow chanell which I call the right Equicurrall ſight, ſo haue you the vocables.

As for the name of this ſtaffe, hee is called the Geodeticall Staffe, of the word Geodetia, which ſignifies a ſcience concerning ſenſible greatneſſe and figure, as hereafter. I might rather haue called him the Mathematicall Staffe, in reſpect of this generality of worke: but I gaue him this name in reſpect of his aptneſſe to meaſure and plat grounds, he hath the addition of Viaticum in reſpect of his portability or aptneſſe to trauell with.

The name of the Staffe.

Chap. III.

Of the Diuiſions of the vpper and lower ſides of both the legs, together with the Graduating of the two ſides of the Graduator, and of the Triple motion he admitteth.

Hauing finiſhed the inſtrument, as before, you ſhall deuide the vpper ſide inward of both the legs in two equall parts, thus: The legs beeing 2. foote and a halfe long, deuide each foote into 12. inches, and then ſubdeuide each inch into 8. parts (or more if you will) then draw parralell lines, and there place figures, as you be wont in ſuch workes, numbring the ſaid parts by 5. from towards the Center, as 5.10.15.&c. (as before) the equall parts muſt be placed vpon the inward ſide of the legs, and vpon the outer ſide, numbred onely on the outer, as in the end of the 7. pro.

Diuiſion of the legges.

The equall Diuiſion vpon the Graduator.

Such diuiſions as theſe are placed vpon the Graduator, as in the 2. Pro. Diſt. You muſt haue a care that ẏ parts be truely deuided, ſo is this kinde of Graduating finiſhed, conſidering well the end of the 7. Prop.

Chap. IIII.

To proiect the degrees of a circle vnto 90. vppon the Graduator, and of the triple motion he admitteth.

The diuiſion of the Graduator for degrees of a Circle to 90.

* See the 6. Pro.

FIrſt take the length of one of the legs, which heere let B C repreſent, then making B C the ſide ſubtending a right angle, thereupon frame an *Orthogonium Iſoſceles, that is, a right angled Tryangle of two equall containing ſides, A B, A C, here repreſents, then making A the Center, with the length of A B or A C deſcribe a Semycircle, then draw C A infinitly beyond A, vntill he interſect with the ſaid ſemicircle at D, ſo is C D the Diameter thereof, then deuide the ſaid ſemycircle into 180. equall degrees, ſo ſhall each Quadrant containe 90. degrees: Now to proiect theſe degrees vpon the graduator, take with your cōpaſſe the length of euery cord in the quadrant C B, and place them in the line C B, repreſenting the Graduator, ſtill keeping the one foote of your compaſſe in the point C.

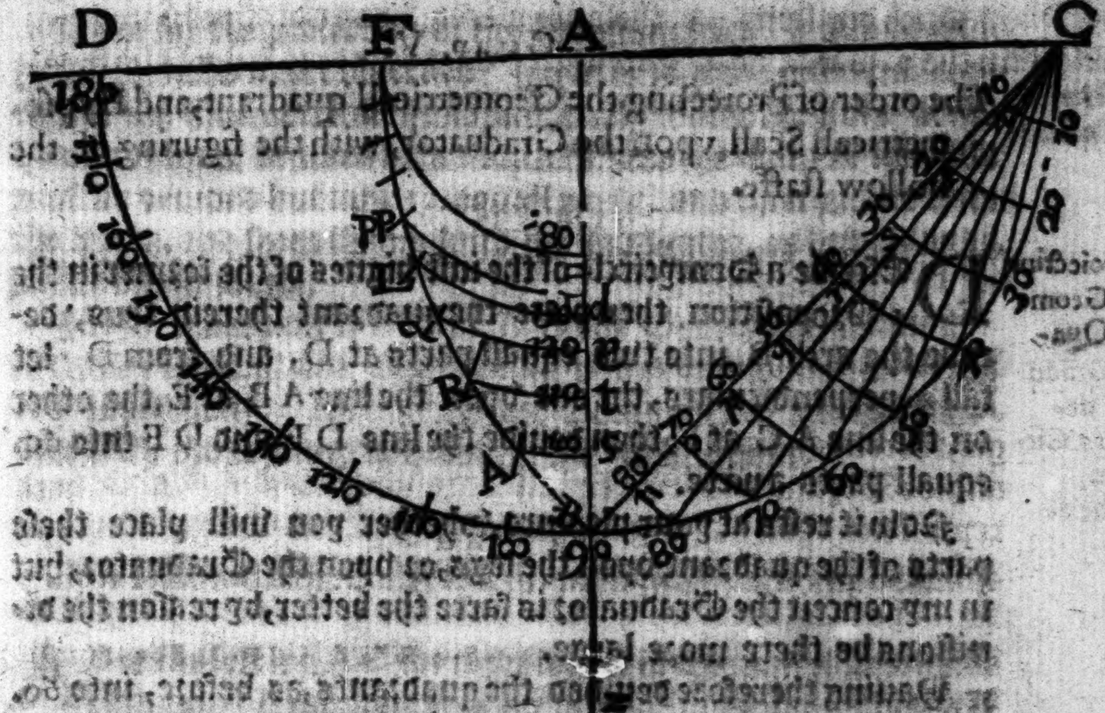
Example.

I take the length of C N, C O, C P, C Q, C R, C S, C T, C V. which is 80.70.60.50.40.30.20. & 10. degrees, & then I put the figures vpon the graduator C B, as they bée here placed, ſo is the degrée of a circle to 90. proiected vpon the Graduator: here note that you muſt take euery degrée in the circle, though I haue put them downe in the demonſtration by 10.20 &c.

Now to proiect the degrees from 90. vnto 180. do thus. Make C ẏ Center, and with the length of C B deſcribe the arch B F: then keeping the one end of a Ruler vpon the Center A, mooue the other end from degrée to degrée in the quadrant B D, noting at euery degrée where the ruler cuts the arch B F: hauing ſo done, you muſt now vnderſtand that theſe degrees are to be proiected vpon the right leg of the inſtrument, and vpon the lower ſide inward thereof, repreſented by A Z: therefore firſt take the length of A B, and place that from the Center of your Inſtrument towards the end of the right leg, and where it ends, make an apparant ſtroke or race round about the ſaid right and left leg, noting the ſame with ſome marke ✝ vpon the outer ſide of both the legs, and where this line ſo drawne doth interſect with the

Of proiecting the degrees to 180. vpon the leg.

ſide



zontiall edge of each leg, there is a point called the point reſpectiue, as in the ſecond Propoſition, Definition 4. Hauing thus done, take the length of A A, and place the ſame in the right leg from the Center towards the point reſpectiue, as A S in the line A B: do ſo to A R, A Q, A L L, A P P, & place the ſame in the right leg A Z from A toward B, ſo ſhall A R be equall to A T, A Q equall to A Y, A L L to A D, and ſo of all the reſt vntill you haue finiſhed each degree vnto 180. you may put ẏ figures thereunto where you ſee beſt occaſion. I hold the fitteſt place to be the hollow chanell in the right leg, becauſe they may there bee ſeene beſt, ſo haue you finiſhed all the graduations belonging vnto the legs, ſauing thoſe in the 7. Propoſition: the graduator deuided as before, and placed vpon the left leg, he admitteth a triple motion; the firſt is along the left leg from one diuiſion to the other, made by mouing his center: ſecondly, to make any Angle with the leaſt leg propoſed, as in the ſecond Booke, Chap. 26.

Point reſpectiue.

The triple motion of the Graduator.

3 To turne any diuiſion on any of the 4. ſides, you pleaſe, the Graduator towards the legs: all which are performed ſimply of themſelues without the letts or helpe the one of the other, as you may moue the Graduator along the left leg, and not alter ẏ Angle he maketh with the ſaid leg, as in the 27. Chapter, Booke 2. or turne any ſide of the Graduator downeward, and not moue him vpon the left leg, or alter the Angle, &c.

Chap. V.

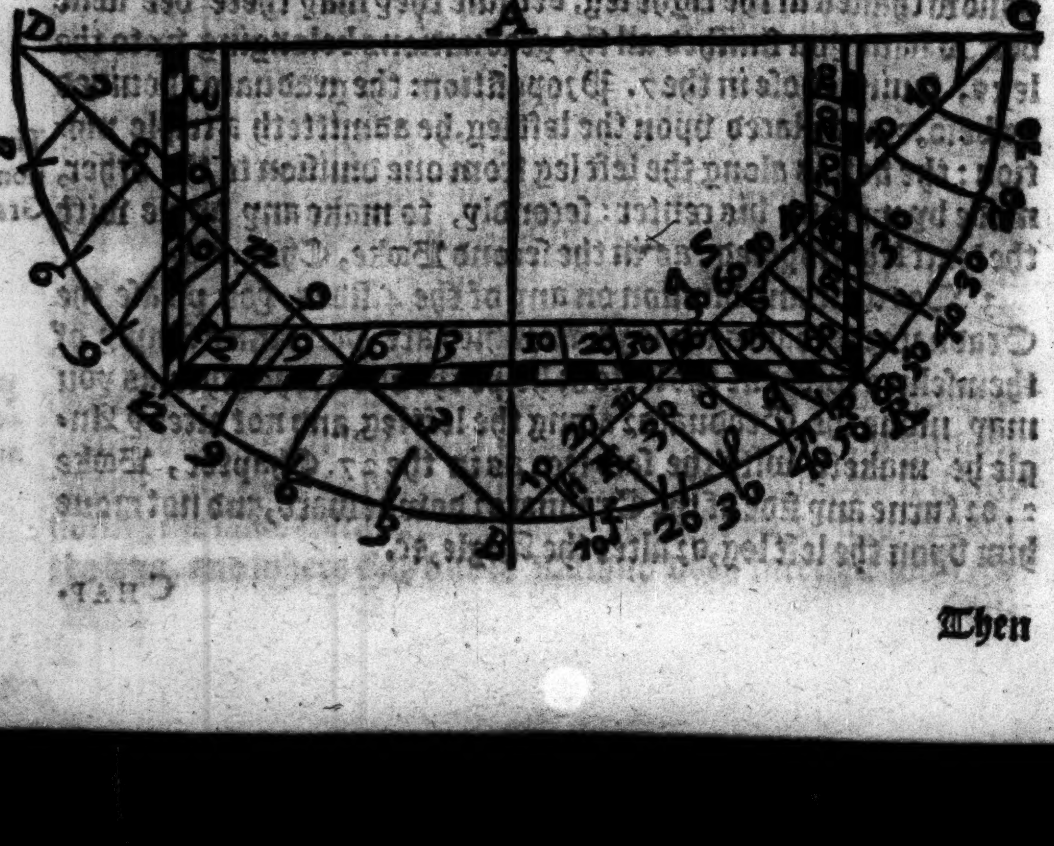
The order of Proiecting the Geometricall quadrant, and Hypſometricall Scall vpon the Graduator, with the figuring of the hollow ſtaffe.

The proiecting of the Geometricall Quadrant.

DEſcribe a Semycircle of the iuſt bignes of the former in the 4 Propoſition, then place the quadrant therein thus, deuide the arch B into two equall parts at D, and from D let fall 2. perpendiculars, the one vpon the line A B at E, the other on the line A C at F, then deuide the line D E and D F into 60. equall parts a peece.

Now it reſts at your pleaſure, whether you will place theſe parts of the quadrant vpon the legs, or vpon the Graduator, but in my conceit the Graduator is farre the better, by reaſon the diuiſions be there more large.

Hauing therefore deuided the quadrants, as before, into 60. equall parts, lay a ruler vpon each part in the line E D and D F, and where it cuts the limbe make notes, and put figures thereunto, as in the figure, the as in the 4. Propoſition making C the center, where you ſhall place the one foote of your compaſſe, take with the other the length of each cord or degree noted in the limbe C B, which place vpon the Graduator C B, ſo ſhall you finde C F equall to C H, C I to C K, C L to C M, C N to C O, C P to C Q, C R, to C S, you may better perceiue the placing of the figures by the demonſtration then with many words, place theſe diuiſions according vnto the ſecond Pro. and 9. Deff.



Then

The Proiecting of the Hypſo-mericall Scall.

Then for the proiecting of the Hypſometricall ſcale vpon ÿ graduator, the order obſerued therein is nothing different from this of the Geometricall quadrant, onely where the ſides of the quadrant were deuided into 60. parts, here the ſides of the ſcale muſt be deuided but into 12. equall parts, and then proiect vnto the limbe, and from thence vnto the graduator, as before, as is plaine by the ſcale.

In the Quadrant B D, ſo is B D the Graduator, deuide into twiſe 12. parts, the figure being placed thereunto, as in the 2. Propoſition, 10. Definition, the Graduator is finiſhed together with the whole graduating of the Inſtrument.

Chap. VI.

Now followeth the Staffe and his parts, with their application.

AB is the left leg, A C the right leg, G is the courſer, and muſt run, and A B the hole: R in the figure F muſt go on the pin B in the figure G.

D E is the Graduator, the pin at the end thereof marked with this figure 4. muſt be put through the hole P in the figure F, & then the ſcrew péece marked with 4. muſt be put on the end of ÿ ſaid pin or courſer, and then you may blunt the end of the pin ſo that the ſcrew ſhall not come off, nor the pin come forth of ÿ hole P, letting the péece F alwaies hang at the end of the Graduator with the ſcrew 4. H. is to ſcrew on the pin B in the figure G, vnder which ſcrew K the hollow pin is to be put vpon the ſaid pin B, ſo that they may the better force downe F. W is the ſite for the center of the legs; A R is the right equicrurall ſight.

Q M and Q N are the points reſpectiue, which you ſhall finde to be iuſt of like diſtance from A, as the length of A B is in the figures of the 4. and 5. Propo.

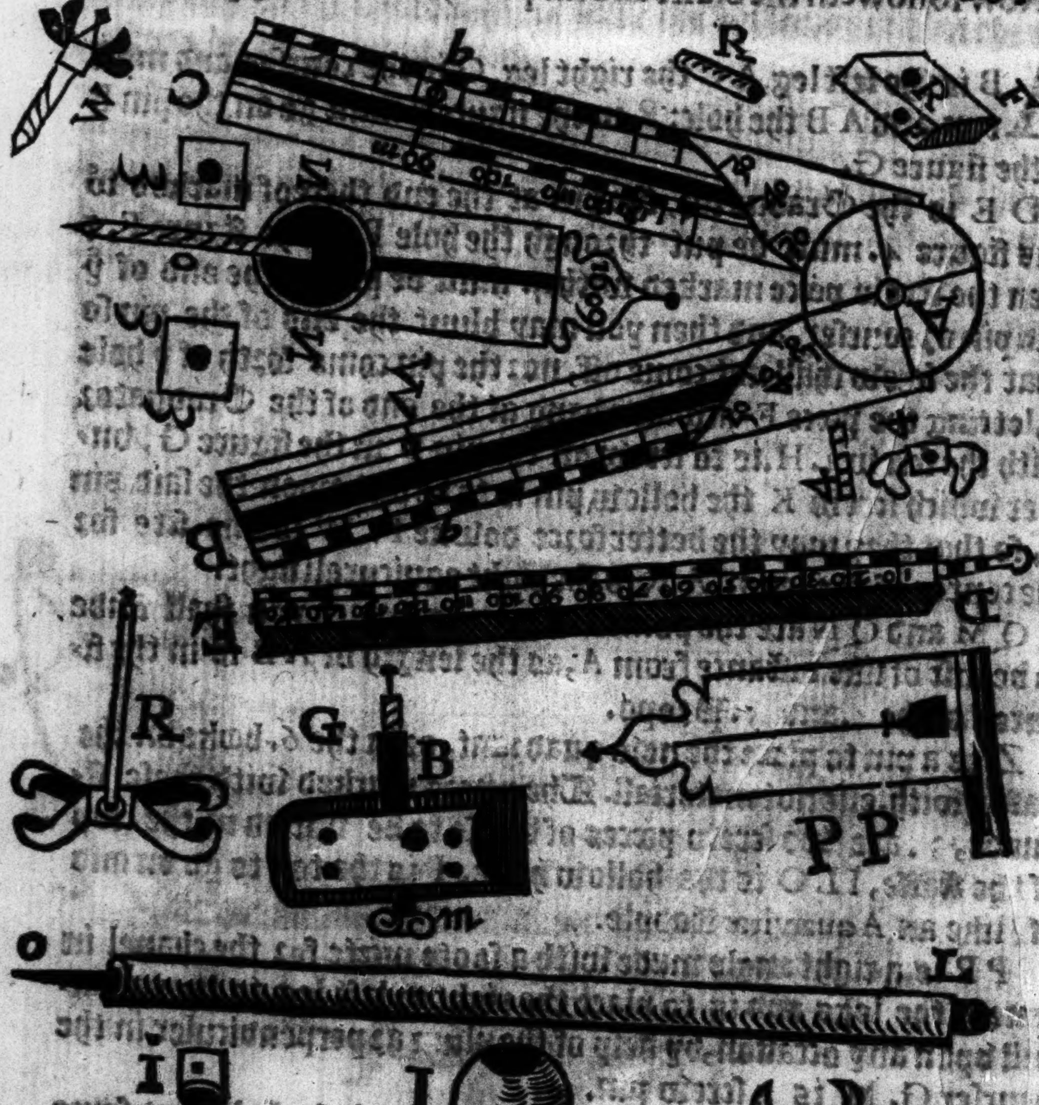
Z is a pin to place the new quadrant, or in the 6. booke on the ſtaffe with, elſe not materiall. The péeces marked with theſe figures, 3. are two ſcrew péeces of braſſe to be buried in the top of the ſtaffe, I L O is the hollow haſſe, I is the top to go on and off like an Aqua vitæ ſtopple.

P P is a right angle made with a foote wiſe for the chanel in [illegible] the legs, and is to place the right or left leg to lie parallell vpon any occaſion, by help of the plum or perpendiculer in the courſer G. M is a ſcrew pin.

In the figure W. the lower and N N ſhould be hollowed ſome ſmall quantity as you may perceiue by the ſhadowed lines, to yͤ end when the pin is preſſed hard, it may force the ioynt of the legs together, and ſo ſtay them at any angle: for if it were not hollow, it would ſtay vpon the riuetting pin of the leg, which the lower end marked with B goes through.

R. As the legs cloſe with the Graduator therein, which beeing thruſt home ſhould be put all into the hollow ſtaffe.

Simulacrum Baculi Geodætitii ſiue viatici: Aſtronomis, Aſtrologis, Geometris Medicis, Politicis, Oeconomicis, Coſmographis, Nauigantibus, & Menſoribus *commodiſſimum, Tyronibuſque facillimum: Per* Arthurum Hopton *de hoſpitij Sanctis Clementis ſocietate conditum & editum.* 1610.



A A Is the Graduation of the equall diuiſions, which muſt be put 5. times vpon this inſtrument, one vpon the one ſide of the Graduator, and twiſe on each leg, as in the 3. and 8. Propoſition.

B B Are chorde deuiſions, and are placed 3. times vpon this Inſtrument, viz. once on the Graduator, as in the 3. Propoſition, and once on each leg vpon the lower ſide outwards, as in the 8. Propoſition, and as they be placed in the figure F.

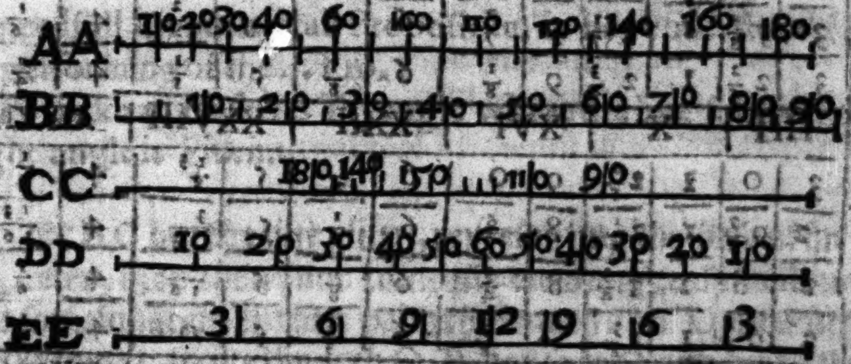
C C Are degrees of a circle from 90. to 180. proiected vpon the right leg A C from M towards A.

D D Are parts of the Geometricall quadrant placed one by one, on one of the ſides of the Graduator, as in the 5. Propoſition.

E E Are parts of the Hypſometricall Scale, placed alſo on the one of the ſides of the graduator, as in the 5. Pro.

These things ſo ordered, you muſt place the three Tables inſuing vpon the outer ſide of the hollow Staffe, which will ſerue you for many pleaſant and neceſſarie vſes; and if your Staffe be too ſmall to hold the Table of the Sunnes altitude, as he may if you make the legges very ſmall (as the vſe is being in braſſe or ſiluer) then may you omitte to ſtamp the minutes on the right hand, each row putting one degree more vnto the degrees, if the minutes anſwering thereunto much exceede 30. and ſo may you place the Table on the ſmalleſt Staffe that is.

The deriuation of all the lines in the Staffe.



The deſcription of the Geodeticall Staffe and the parts thereof, which you may haue ready made by M. *Reade* and *Iohn Tomſon* in Hoſier lane, neare Smithfield in London.

The Table for Bord and glaſſe meaſure &c. called *the Table of Planimetria.*

			VI		XII		XVIII		XXIIII		XXX	
p.	foot	yn	foot	yn:	yn:	par:	yn:	par:	yn:	par:	yne:	par:
			2	0	12	0	8	0	6	0	4	4/5
1/4	48		1	11 1/25	11	3/4	7	7/8	5	15/16	4	3/4
1/2	24		1	10 1/7	11	1/2	7	4/5	5	7/8	4	5/7
3/4	16		1	9 1/3	11	2/7	7	2/3	5	4/5	4	2/3
	I		VII		XIII		XIX		XXV		XXXI	
1	12		1	8 4/7	11	1/16	7	4/7	5	3/4	4	7/11
1/4	9	7 1/5	1	7 6/7	10	7/8	7	1/2	5	2/3	4	3/5
1/2	8	0	1	6 1/5	10	2/3	7	3/8	5	5/8	4	4/7
3/4	6	10 2/7	1	6 4/7	10	1/2	7	2/7	5	3/5	4	1/2
	II		VIII		XIIII		XX		XXVI		XXXII	
1	6	0	1	6	10	2/7	7	1/5	5	1/2	4	1/2
1/4	5	4	1	5 3/7	10	1/10	7	1/9	5	1/2	4	1/2
1/2	4	9 3/5	1	4 15/16	9	15/16	7	1/32	5	3/7	4	3/7
3/4	4	4 4/11	1	4 3/7	9	3/4	6	15/16	5	3/8	4	2/5
	III		IX		XV		XXI		XXVII		XXXIII	
1	4	0	1	4	9	3/5	6	6/7	5	1/3	4	1/3
1/4	3	8 1/3	1	3 4/7	9	3/7	6	4/5	5	2/7	4	2/7
1/2	3	5 1/7	1	3 1/7	9	2/7	6	5/7	5	2/9	4	1/6
3/4	3	2 2/5	1	2 3/4	9	1/7	6	5/8	5	1/5	4	1/4
	IIII		X		XVI		XXII		XXVIII		XXXIIII	
1	3	0	1	2 2/5	9	0	6	1/2	5	1/7	4	1/4
1/4	2	9 7/8	1	2 1/21	8	6/7	6	1/2	5	3/32	4	13/64
1/2	2	8	1	1 3/4	8	3/4	6	3/8	5	1/16	4	1/6
3/4	2	6 1/3	1	1 3/8	8	3/5	6	1/3	5	0	4	1/7
	V		XI		XVII		XXIII		XXIX		XXXV	
1	2	4 4/5	1	1 1/11	8	1/2	6	1/4	5	0	4	1/9
1/4	2	3 3/7	1	4/5	8	1/3	6	1/5	4	[illegible]	4	3/32
1/2	2	2 2/11	1	1/2	8	1/4	6	1/8	4	7/8	4	1/16
3/4	2	1 1/23	1	2/7	8	3/32	6	1/16	4	5/6	4	1/32

A Table to be placed vpon the hollow ſtaffe, ſeruing *for the number of Timber meaſure, and therefore I aptly call him*

The Table of Solidmetria.

S	Fo	Inc:	S	Inc:	Par	S	In:	P	S	In:	Pa
1	144	0	10	17	$\frac{2}{7}$	19	4	$\frac{25}{32}$	28	2	$\frac{1}{5}$
2	36	0	11	14	$\frac{2}{7}$	20	4	$\frac{5}{16}$	29	1	$\frac{1}{16}$
3	16	0	12	12		21	3	$\frac{11}{12}$	30	1	$\frac{11}{12}$
4	9	0	13	10	$\frac{11}{5}$	22	3	$\frac{4}{7}$	31	1	$\frac{4}{5}$
5	5	$9\frac{3}{25}$	14	8	$\frac{13}{16}$	23	3	$\frac{1}{4}$	32	1	$\frac{11}{16}$
6	4	0	15	7	$\frac{2}{7}$	24	3	0	33	1	$\frac{5}{8}$
7	2	$11\frac{2}{7}$	16	6	$\frac{3}{4}$	25	2	$\frac{3}{4}$	34	1	$\frac{1}{2}$
8	2	3	17	6	0	26	2	$\frac{9}{16}$	35	1	$\frac{3}{7}$
9	0	$21\frac{1}{3}$	18	5	$\frac{1}{3}$	27	2	$\frac{3}{8}$	36	1	$\frac{1}{3}$

This Table was calculated by M. Digs, and alſo the former, which are beſt to be placed vpon the backeſide the legs, as ordinarily they be ſet vpon the Carpenters Rule, as is taught in M. Digs his Tectonicon.

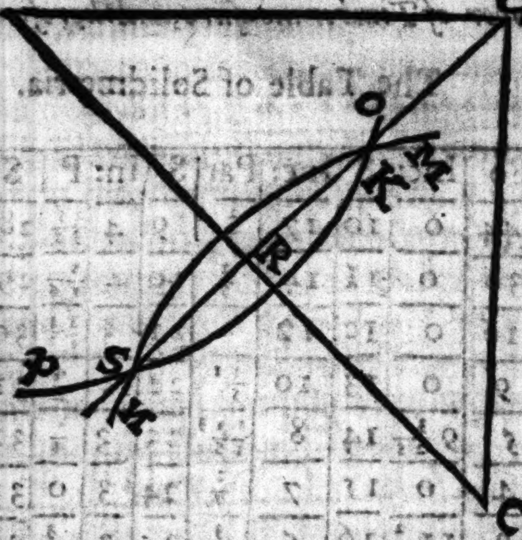
In the foote of this ſtaffe, there muſt be a ſteele picke, and in the top, two peeces of Braſſe, with a ſcrew hole therein for the center pin, W to faſten A the center of the inſtrument thereunto, yͤ on of theſe ſcrew peeces, muſt ſtand in yͤ top of the ſtaffe, yͤ other in the ſide, as neare to the top as you can, the firſt ſerueth to take angles of latitude, that which is in the ſide ſerueth to place the legges to take Angles of altitude, as will appeare in the ſecond Booke. Propo.

Pro. VII.

A needfull Geometricall Propoſition to bee vnderſtood for the performing of the 4. Pro.

To make an Iſoſceles Tryangle where the line ſubtending the right angle is giuen.

LEt B C bee the line giuen, repreſenting the baſe of an Iſoſceles, then open your compaſſe vnto any reaſonable diſtant (as ſomewhat more then halfe the length of B C, making then B the center, ſtrike the arch O P, doe ſo to C, and make the arch M N, now theſe two arches ſhall interſect one the other twiſe, as at I. and K. laying a rule on thoſe two points I K draw the line I A infinite beyond K, ſo is C B deuided into two equall parts at R, then place the length of R C or R B in the perpendicular R A, placing the one foote of the compaſſe in R, and when



the other falles, make a point as at A. Laſtly draw the line A C and A B, ſo is your Iſoſceles Tryangle made, A beeing a right angle in the Tryangle B A C. This Propoſition I placed here for thoſe that be but meanly read in Geometry, becauſe ẏ ſhould not be ſcaled in any thing neceſſary for the performing of this Inſtrument. Here I ſhould proceede in opening further the termes of Geometry, which I will omit becauſe it is growne ſomething common, and alſo for that I haue collected them into one volume in my Epitome of Geometry, namely in the firſt part called Euthymetria.

CHAP. VIII.

These former Tables orderly placed vpon the outer ſide of the Staffe, yet there remaineth other of diuiſions, which are to be placed vpon the lower and outer ſides of the legs, and vpon the vpper and outer ſide of the ſaid legs, that is the chords of a circle to 60. and the equall parts, which ſhall ſerue for many pleaſant vſes, as hereafter.

The order of placing the Chords of a circle and equall diuiſions, vpon the vtter ſide of the legges of the Geodeticall Staffe.

The Chorde Diuiſions.

VVE will take the figure in the 4. Prop. but firſt prepare the ſtaffe ſo that he may be apt for thoſe diuiſions: you ſhall firſt therefore at the point reſpectiue, make a marke in each legge on the lower ſide, halfe a quarter of an ynch, or thereabouts, from the frontall edge of the legges. Which done, draw a ſtrait line from the Centre, direct to the two former points, made at the points reſpectiue, then draw parrallelled lines thereunto, to place the figures at, as the common order is.

Now for graduating the chords of a circle, on each legge, the worke is nothing different from the projecting of the degrees of a circle vnto 90. vpon the Graduator, as in the 4. Prop. therefore the center of the Graduator, being placed at the Center of the leges, & the degree of a circle being turned towards the legs, you might truly thereby marke out the chords vpon each legge, vnto 90. ſo will yͤ 60. degrees vpon yͤ Graduator, iuſt touch the point reſpectiue. Otherwiſe you may fetch the ſaid degree from the circle, with your compaſſe, placing them vpon the one of the legs from the center. The one legge thus deuided, you ſhall then deuide the other leg in the ſame order, putting figures thereunto, and numbring the degrees by 10. as 5. 10. 15. 20. &c. as you did vpon the Graduator vnto 90. You ſhall finde that theſe degrees will help you to performe many ſingular Propoſitions, as will plainly appeare in the 6. Booke.

Of the equall diuiſions.

Of the equall Diuiſions.

To place the chords of a circle vpon the lower and outer ſide of the legs, I bade you draw a line in each leg that ſhould be produced from the Center, ſo that the ſaid right lines might runne ſloping wiſe a certaine diſtance from the fiduciall edge of each leg: I ſaid halfe the quarter of an inch at the points reſpectiue, would ſuffice, and ſo it will; and here I let you to wit that the like ſloping lines as theſe muſt be placed vpon the vpper and outer ſide of each leg, with parrallell lines drawne for the deuiſions and figures, as you did for the chords; theſe ſloping lines muſt be deuided according vnto 8. in the inch, and numbred by 5. as 5.10.15.20.&c. they be the ſame diuiſions that are placed vpon the vpper inward ſide of each leg, and are called equall diuiſions, as in the 3. Propoſition: and note if you pleaſe, you neede not ſet any figures vnto the equall diuiſions on the inward ſide of the leg, becauſe thoſe on the outer will ſerue for both: onely draw parrallell lines producing the diuiſion at euery 5. and 10. notwithſtanding if the roome will admit figures, ſtamp them there.

A Table containing the degrees and minutes of the Sunnes altitude for euery howre in the yeare, exactly calculated for the latitude of London.

Capri.		Iune.	69	12		11		10		9		8		7		6		5		4	
				G	M	G	M	G	M	G	M	G	M	G	M	G	M	G	M	G	M
	0	12	0	62	0	59	43	53	45	45	42	36	42	27	23	18	11	9	28	1	33
	20	22	10	61	37	39	21	53	26	45	24	36	25	27	6	17	54	9	9	13	
	10	33	20	60	30	58	17	52	28	44	32	35	35	26	16	17	3	8	16	0	16
				12		1		2		3		4		5		6		7		8	
Gemi.		Iuly.	Leo.	12		11		10		9		8		7		6					
	0	13	0	58	42	56	34	50	55	43	6	34	13	24	56	15	41	6	50	0	0
	20	24	10	56	17	54	15	48	48	41	10	32	22	23	8	13	50	4	55	0	0
	10	34	20	53	21	51	26	46	12	38	46	30	6	20	52	11	34	2	34	0	0
				12		1		2		3		4		5		6		7			
Taur.		Aug.	Vir.	12		11		10		9		8		7		6					
	0	13	10	50	0	48	11	43	11	35	33	27	2	18	1	8	9				
	20	24	10	46	20	44	37	39	51	32	53	24	32	15	27	6	8				
	10	34	20	42	23	40	51	36	18	29	34	21	24	12	15	3	6				
				12		1		2		3		4		5		6					
Arie.		Sept.	Libr.	12		11		10		9		8		7							
	0	13	0	38	30	36	58	32	37	26	7	18	8	9	16						
	20	23	10	34	32	33	4	28	55	22	33	14	51	6	7						
	10	33	20	30	40	29	16	25	18	19	14	31	38	3	2						
				12		1		2		3		4		5							
Piſces.		Octo.	Scor.	12		11		10		9		8		7							
	0	14	0	27	0	25	40	21	51	15	50	8	13	6	0						
	20	24	10	23	39	22	22	18	42	13	1	5	5	0	0						
	10	33	20	20	43	19	29	15	55	10	23	3	17								
				12		1		2		3		4		5							
Aqu.		Nou.	Sagta.	12		11		10		9		8									
	0	12	0	18	18	17	6	13	38	3	3	1	15								
	20	22	10	15	30	14	48	11	55	6	36	0	0								
Capri.	10	32	20	15	23	14	13	10	52	5	36	0	0								

THE SECOND BOOKE OF the Geodeticall Staffe, ſhewing the ſearching and ſpeedie finding out of all Longitudes, Latitudes, Altitudes and Profundities, together with the Angles and ſides of Tryangles (without the help of Arithmeticke, Protractor, Scale & Compaſſe, or any other cumberſome appendant whatſoeuer) *as well Aſtronomicall, as Geometricall, and that after two maner of waies; both pleaſant, ſpeedie and neceſſary: alſo you are taught with facilitie to worke the Golden rule on the ſaid Staffe.*

CHAP. I.

Of the Art of Geodæſia, together with the maner of vſing of the Geodeticall Staffe, with the things therein to be conſidered.

AS the Elements of Geometry ſerue to expreſſe the magnitudes in determined ſpecies or figures, and their diuerſe affections by definitions & propoſed theoremes, whereby we haue the theoricall or contemplatiue part; ſo this art of Geodæſia doth explicate or adumbrate the vſe of thoſe propoſitions and theoremes, certainly & by infallible grounds, in any materiall ſubiect, whereby wee haue the actiue and practicall part. Therefore may we define Geodæſia to be an art, which doth ſearch out the quantity of any materiall magnitude propoſed to be meaſured, expreſſing the ſame to vs in a knowne meaſure; ſo that it is written, *Geodæſia eſt ars, quæ propoſitæ magnitudinis quantitatem nota quadam menſura inuenit.* But the very emphaſis of the word it ſelfe doth imply a proper application, in reſpect of our intended meaſuring of ground; for the word ſignifieth *Terræ diſtributio*, or *Terrarum partitio*: and therefore we may aptly call the art of meaſuring ground, the art of Geodæſia. So now in this art of meaſuring two things happē to be conſidered, that is, the materiall ſubiect, propoſed to be meaſured, and the inſtrumentall cauſe, by which it is meaſured. This ma-

Geodæſia quid.

D. Ryff.

In Geodæſia duo conſiderandæ veniunt.

De ſubiecto Geodeſiæ.

materiall ſubiect is conſidered as well according vnto his kinds and forme, as according vnto his adiuncts.

Genera magnitudinis quid.

By the kindes of magnitude is vnderſtood, whether or not ẏ thing propoſed to be meaſured, be liniall or linamentall, and thereby whether an Angle or a figure: and if a figure, whether plaine or Solide: if plaine, whether a right line or a curued line: if right lined, whether a Tryangle or Tryangulated: and ſo forth, for it is a Geodeticall ground:

Axioma Geodæti.

Omnis magnitudo cognomine menſura genere menſuratur.

So lines are meaſured by lines: for the purpoſe, it is required to know the length of London bridge, that is laid open by a right line, which doth equall the longitude of the bridge: but ſuperficies are meaſured by ſuperficies, as an aker is ſo many feete ſquare &c. ſo likewiſe ſolids are meaſured by ſolids, as hereafter.

Affectio magnitudinis.

Now in the knowledge of theſe kinds of magnitude, the affection whereof doth offer it ſelfe to be conſidered, that is to ſay, whether or no the lines to be meaſured be right or oblique, and in thoſe liniaments whether the propoſed figure be ordinary or inordinary &c. as whether the giuen tryangle doe anſwere vnto an Orthogomium, Amblygonium, or an Oxigonium &c. for you muſt note ẏ you may meaſure right lines by this geodetical Inſtrument after 2. waies, that is, either naturally or artificially.

Menſuratio, lineæ duplex.

Naturalis menſu. lin.

The meaſuring of right lines naturally by this Inſtrument, is perfected by the cōgruency of the thing meaſured with ẏ meaſure it ſelfe; ſo a longitude 4. foote long (as the Staffe) is abſolued by the appellation in meaſure of foure foote; ſo a yard being meaſured, is called three foote, or 36. inches, or 180. barly cornes, &c.

Artificialis Menſ. lin.

In vſu Baculi Geodetici duo conſideranda.

Aptitudo menſoris.

Viſus infinitus.

But the artificiall meaſuring of things being moſt commodious, is performed by my Geodeticall Staffe otherwhere; wherein two things be occurrant or ſeeme fit to be preconſidered, that is, the aptneſſe of the meaſurer, and the diuerſitie or anomality of Tryangles, as in the 12. Chapter: but for the aptneſſe of the meaſurer, firſt he muſt haue a care that the ſight be not infinite, that is, if the thing whoſe diſtance from you is ſought, be not ſo farre off, that the eie cannot beare the viſuall beames thereunto forcibly.

Obductus oculus.

2 That you alwaies winke on the one eie; in ſo doing, the ſight is made more ſtrong and forcible for a long diſtance, *vis nãque optica e duobus oculis in vnum cōducta, firmius collimat.* Here we ſhall not neede *manus quieta*, as the Iacob, and ſuch other ſtaues require.

3 That your ſtationary line, or line that you meaſure, be not too ſhort; for the longer your line is, the truer you worke; one 8. part of the diſtance is a good length: and note if the diſtance be a mile or 2, or 3. &c. neuer expreſſe your ſtationary line by feete or yards, but by pearches or ſcores, or ſuch great meaſures, becauſe there be not ſo many diuiſions vpon the leg haply as there be féet or yards in the diſtance &c. though there may be as many ſcore or pearches, yet you may make ſhift to help that by imagining euery diuiſion in each leg, to be ſubdeuided into 2. 3. 4. or 5. parts, and ſo procéed.

Linea Data.

M. Blagraue.

4 Let the angle betwixt the 2. ſtat. and the marke whoſe diſtance is required, be as neere vnto a right angle as you may, rather a little leſſe then more: and as in the 3. note I ſhewed you how to increaſe the diuiſions for long diſtance, ſo for ſhort diſtāces you may reckon euer 10. for one, ſo in leuying one cypher from each number, your ſtaffe is readily deuided.

Chap. II.

Of Engliſh meaſures, both old and ſuch as be allowed by our ſtatutes, and of the comparing of them together, with the difference that riſeth betwixt any of them, in an aker of ground.

I go about here to ſpeake of Engliſh meaſures, becauſe through the want of knowledge thereof many abſurdities by the vnſkillfull practitioners be daily committed: for ſome count the Italian miles and ours to agrée; ſome ſeeming to be more wiſe giue a little difference betwixt the ſame, which they ſay is not apparant or ſenſible, all which is a moſt palpable abſurdity. For the true Italian mile containes 5000 feete, and the true Engliſh mile containes 5280. feete: ſo that our Engliſh miles be longer then the Italiā miles by 280 féete, which I thinke is a difference ſenſible inough for any man of iudgement to perceiue. If ſome of our more then curious heads were no better perſwaded of themſelues, they would neuer go about to affirme they can fetch you a true diſtance to the inch (nay I haue heard ſome vouch the barly corne) vpon their ſcale w the plaine table Theodilitus &c, whē I haue ſmiled at their ſimplicities, ſeeing them maintaine ſuch impoſſibilities: for how can they expreſſe the inch vppon their ſcale, when the 16. or 17. perhaps the 30. part of an Inch ſtands for a pearch or mile? I will maintaine againſt ſuch, that vpon a ſcale of aboue 20. parts in the inch, they can hardly expreſſe a di-

Milli. Italicum.
Milli. Anglicū.

Vnleſſe they vſe the ſcale in the 5. Booke, or lib. 6. Chap. 42.

diſtance vnto the yard, but for feare of digreſſion, let vs ouer-paſſe ſuch ouer-curious conceited Artiſts.

Falſe pearches.

Anno. 33. Ed. 1

Tenant-right meaſure.

Curt meaſure.

Wood-land meaſure.

As many vſe a falſe mile for our engliſh mile, ſo diuerſe vſe falſe pearches, when we haue one onely pearch allowed by Statute: for in ſome places in this kingdome, notwithſtanding the * Statute prouided for the contrarie, they vſe twelue foote in a pearch, vnto the great loſſe of the buyer, wherewith they bee accuſtomed to meate medowes, calling it Tenant-right meaſure; of no word of art, but onely implying (as I take it) to be a right and proper meaſure belonging vnto Tenants: for ſo the word it ſelfe imports. Others more proper and agreeing vnto the nature of the ſaid meaſure, call it Curt meaſure, likewiſe before yͤ ſaid Statute (which many vnto this day vſe) a pearch of 18. 20. and 24. feete, called VVoodland meaſure: all which differ from the true and allowed meaſure, in ſuch ſort as enſueth.

One aker of 12. feete in the pearch, containes of Statute meaſure
Ro. Da. 76
2. 1. 121. of a Pearch.

One aker of 18. foote in the pearch, containes of Statute meaſure
Ac. Da. Perch.
1. 7. 2. 50/1099
Vſed in moſt places for wood-land meaſure yet.

One aker of 20. foote in the pearch, containes in Statute meaſure
Ac. Ro. Per.
1. 1. 3. 603/1089

One aker of 24. foote in the pearch, containes of Statute meaſure
Ac. Da. Per.
2. 4. 2. 60/121

By this that is ſaid, you may gather the diuerſities of meaſures vſed by many, together with the great loſſe or gaine to the buyer or ſeller, according as the leſſe or greater meaſure is vſed: but for the true meaſure which ſhould bee meaſured through England, take it thus.

Compoſitio vlnarum perdicarum &c.

Pearch.

Day-worke.

Rood.

Three barly cornes dryed, and taken out of the middeſt of the eare, make one inch of aſſize: 12. ſuch inches make one foote; one foote and a halfe make a cubite: two cubits or three feete make one yard: two yards a fadome: 5. yards and a halfe, a pearch: one pearch in bredth, and foure in length make a day-worke: ten day-workes make a Roode (of ſome called Farthendell:) but more plaine the quarter of an aker, containing 4. pearches in breadth, &

ten in length, or 5. in breadth, and 8. in length, all is one: one pearch in breadth, an 160. in length, make an aker: or foure pearches in breadth, and forty in length, make a true aker; ſo that an aker by Statute ought to cōtain 6272640. ſquare inches, which is 43560. ſquare feet, 4840. ſquare yards, or 160. ſquare perches.

Aker.

Againe for meaſures in longitude, 4. feet is an ell, 16. elles or 20. yards a ſcore, 40. pearches a furlong, 8. furlongs a mile, as in the enſuing Table.

Fabian a Chronogapher writing of the Conquerour, ſets downe in the hiſtory thereof another kinde of meaſure, very neceſſary for all men to vnderſtand; foure akers (ſaith he) make a yard of land, fiue yards of land contain a hide, and 8. hides make a Knights fee, which by his coniecture is ſo much as one plough can well till in a yeare; in Yorkeſhire and other countries they call a hide an Oxe ſkinne.

Yard of land.
Hide of land.
A Knights fee.

A new and true Table of Engliſh meaſures,

according vnto the Statute.

Barly corn.	3	36	54	108	135	216	594	1460	33760	190080
	Inch.	12	18	36	45	72	198	720	7920	63360
		Foote	$1\frac{1}{2}$	3	$3\frac{3}{4}$	6	$16\frac{1}{2}$	60	660	5280
			Cubit	2	$2\frac{1}{2}$	4	11	40	440	3520
				Yard.	$1\frac{1}{4}$	2	$5\frac{1}{2}$	20	220	1760
					Elle.	1 3 foot	4 In 18	16	176	1408
						Fadō	$2\frac{3}{4}$	10	110	880
							Perch	3 Cu. 7	40	320
								Score	11	88
									Furlong	8
										Mile.

Now I haue giuen you a perfect Table of our Engliſh meaſures, I will procéede vnto ſuch meaſures as be vſed by the Geometritians, and men of other countries, to the end you may both ſée the difference thereof, and alſo apply your Staffe thereunto, being occaſioned by any meanes whatſoeuer.

CHAP. III.

Of the parts of Geometricall menſurations.

Menſura quid.

P. Ryff. Francofur.

APian in his Coſmography ſaith, that meaſure is a finite or determinated longitude, whereby is meaſured the vnknowne diſtance of places: but a late Germane Doctor, calleth all thoſe meaſures that do not excéede the height of a perfect mā, menſuræ minores, wherewith ſaith he, wee meaſure things naturally, ſetting aſide arte: but thoſe as exceede the ordinary ſtature of a man, he calleth menſuræ maiores, which are compoſed of the leſſe meaſures. And heere you ſhall note that the parts wherewith Geometricians vſe to meaſure with, are called:

Partes menſuræ.

1 Granum hordeaceum, a graine or corne of barly.

Digitus.

2 Digitus, a finger containing 4. graines.

Vncia.

3 Vncia ſeu pollex, an inch containing 1.$\frac{1}{3}$ fingers, but after Apian 3. fingers.

Palmus.

4 Palmus minor, of Apian called palmus onely, containing 4. fingers.

P. R. Spithama.

5 Spithama, alii dicunt, palmus maior, a ſpanne, the diſtance betwixt the little finger and the thumb ſtretched out, which cōtaines 3. hand-breadths, or 12. fingers. Apian puts a meaſure called Dichas, after palmus, which containes 8. fingers.

Dichas.

Pes.

6 Pes, a foote containing foure palms, or 12. inches.

Seſquipes.

7 Cubitus ſeu ſeſquipes, which is a meaſure of one foote and a halfe, or 6 palmes.

Gradus.

8 Gradus ſiue greſſus, a Gréeſe, a ſtep, containing two féete, but with Apian 2 feete: otherwiſe it were all one with his paſſus ſimplex.

Paſſus Geodæticus.

Paſſus Geometricus.

9 Paſſus, a pace, two grades containing 5. geodeticall feete: but wͭ Apian this meaſure is called Paſſus Geometricus, which he ſaith is vſed in Coſmometra.

Orgya.

Menſuræ maiores.

10 Orgya, a fathom, containing 4. cubits or 6. féete: here ſome make a diuiſion, calling the meaſures henceforth, menſuræ maiores.

Pertica.

11 Pertica ſiue virga, a rod, a pearch, a pole, which among the Romanes was 10. foote, and ſo doth Apian take it: but with the Germanes now it is commonly taken for 16. feete, agreeing neare with our pearch.

12 Stadium, a meaſure of ground, containing 125. paces, or 625. féete. There be thrée ſorts of this meaſure, the firſt is that of Italic or Germany, as we haue ſpoked of alreadie: the ſecond Olympicum, of 600. féete, which is 120. paces: and the third is Pythicum, of 100. féete, that is 200. paces: of theſe Stadia, 8. make an Italian mile, containing 1000. paces, euery pace béeing 5. féete.

Stadium.
Italicum.
Olympicum.
Pythicum.
Milliare Italicum.

I haue read of a difference betwixt Plinie and Diodorus Siculus, in the diſcerning of Sicile, which haply may grow by occaſion of the diuerſitie of theſe ſtadia.

Plinie, & Diodorus.

Apian henceforth procéeding calles firſt,

13 Leuca, a league, with ſome containing 1500. paces.

Leuca.

14 Miliare Italicum: the Italian mile hath 1000. paces, or 8. ſtadia.

Miliare Italicũ.

15 Miliare Germanicum, the Germane mile hath 4000. paces.

Germanicum.

16 Miliare Germanicũ magnum, hath 5000 paces, which they hold a ſufficient iourney for a reaſonable hodeper or traueller to go in two houres.

Germanicum magnum.

17 Miliare Germanicum commune, the common Germane mile hath a 32. ſtadia.

Miliare commune.

And you muſt vnderſtand that the Italians (which Apian called the Latines) and wée of great Brittaine, doe meaſure our great diſtances vpon the earth by miles, the Grecians by ſtadia, or furlongs, the French and Spaniſh by leucas or leagues; and yet they all differ in the length of their leagues: for the French league containes two Italian miles, and the Spaniſh league 3. Italian: yea in ſome places of high Germany their league is ſo long as a man can ſcarce ride thrée of them in a whole day, as in Sueuia, for the great leagus of Germany containes fiue Italian miles, which is nothing in compariſon of the leagues neare Sueuia. Now the Egyptians meaſure the great ſpace of the earth, by ſignes, the Perſians by Paraſangus, which as I coniecture is a meaſure of ground containing 30. furlongs, but as ſome write, 50. furlongs.

Leuca Gall.
Leuca Hiſpa.
Mag. Germa. leu.
Leuca Germa.
Paraſanga quid.

Thus you ſée the diuerſitie of meaſures according vnto the cuſtome of the country, but I maruaile how our yards &c. and the French & Spaniſh, ſo differ, ſéeing the originall of them both is all one: for as well they, as wée, haue 3. barly cornes allowed vnto one inch, and ſo forth, as in the ſecond Chapter; and yet it is found that a French foote at Paris, is more then ours by one inch, and the Italian foote to be longer then ours by 2. inches and neare a quarter; and yet their miles be ſhorter then ours, as in the ſecond Chapter. * Some write that the Germane foote is leſſe then ours by two inches and a halfe, ſo that the Italian foote by this account, ſhould be longer then the Germane by 4. inches and neare three quarters: but I would wiſh thee to apply thy ſtaffe onely vnto our Engliſh meaſures before, vnleſſe thou ſhouldeſt make any mappe or ſuch like for other countries, or conferre former workes with thy owne, to the which end I haue wrote this Chapter, and ſet downe the enſuing Table.

* Stophlerus.

A Table of the leſſer ſort of Geodeticall meaſures.

Granū	Digitꝰ	Vncia	Palmꝰ	Spithama	Pes	Cubitus	greſſus	Paſſus	Orgia	
Granum	4	5 1/3	16	48	64	96	160	320	384	640
	Digiti	1 1/3	4	12	16	24	40	8	96	160
		Vncia	3	-9	12	18	30	60	72	120
			Palmi	3	4	6	10	20	24	40
				Spithamæ	1 1/3	2	3 1/3	6 1/3	8	13 1/3
					Pedes	1 1/2	2 1/2	5	6	10. alias 12. vel 16
						Cubiti	1 2/3	3 2/3	4	6 2/3
							Greſſus	2	2 2/5	4
								Paſſus	1 1/5	2
									Orgiæ	1 2/3

Chap. IIII.

Of Geodeticall Angles, and how to vſe the Staffe in taking them.

These angles which I call Geodeticall, be ſuch as haue relation vnto things ſcituate vpon the earth, containing in them ſenſible greatneſſe, and figure, in the vſing whereof, wee attaine vnto the practicall part of Geometry: they be 4. in number, that is, Angles of Longitude, Latitude, Altitude, and Profunditie, which indéed is but a reuerſed Altitude.

Angul. Geodet.

Pro. 1.

Angles of Longitude.

Angul. longitudinis.

Angles of Longitude be ſuch as be taken vpon plaine or hilly ground, lying before you in a right line, and be thus performed: place the legs vpon the ſide of the Staffe, & then bring the left leg euen with the hollow ſtaffe, placing the ſaid ſtaffe perpendicular, by the 5. Chap. then moue the right legge vp and downe, vntill by the center pin, and the ſight in the fiduciall edge thereof, you eſpy the marke, whoſe diſtance from you is required: ſo is the Angle taken, which if you will expreſſe in degrées, repaire vnto the 5. Chapter.

Pro. 2.

Geodeticall Angles of Latitude.

Anguli geodætici latitudinis.

Angles of Latitude, be ſuch as bee taken in ſéeking the diſtance betwixt two Towres, Trées, Stéeples, or ſuch like, wherein there is no regard to be taken of the perpendicularity, or the paralitie of the legs, or the ſtaffe: but alwaies are placed at the pleaſure of the Geodetor, or Menſor; you may choſe whether you will place the legs vpon the top of the ſtaffe, or hold thē in your hand only: the ſtaffe is Manus quieta, the maner of their taking is thus: Turne the left legge towards the marke vpon your left hand, vntill by the top of the center pin, and the ſight in the left leg, you ſée the ſaid marke vpon your left hand, that leg reſting, remoue the right, vntill (likewiſe) by the cẽter pin & right ſight, you ſée the marke vpon the right hand: the legges reſting, you haue the quantity of the Angle, which if you will expreſſe in degrées or parts of the quadrant, reſort vnto the 5. Chapter.

Angul. Aſtrono. latitudinis.

No otherwiſe are * Angles Aſtronomicall taken.

PRO. 3.

Geodeticall Angles of Altitude.

Angul. Geoda. altitudinis.

Angles of Altitude, be ſuch as bee made in the taking the height of Turrets, houſes, trees, &c. Wherein it is conuenient that the left leg lie alwaies parallell vnto the Horizon, as in the 5. Chapter: then turning the right leg vnto the ſummite or top of the Altitude, looking by the ſights, as before the Angle is taken.

Altitudinem ſtellarum inuenire.

And no otherwiſe are Aſtronomicall Angles of Altitude takē: for there it is moſt requiſite that the left leg lie alwaies parallell vnto the Horizon, and the right leg point vnto the Sunne or ſtarre: but becauſe you cannot looke vpon the ſun if his beames be forcible, take either of theſe enſuing waies.

Solis altitudinē extrahere.

Hauing placed the left legge parallell to the Horizon, the end thereof pointing towards the ſunne, heaue vp or put downe the right legge, vntill the ſhadow that the ſight in the right legge yeeldeth, agrée with the frontiall edge of the ſaid right legge: ſo is the Angle taken; which to expreſſe in degrees, reſort as before vnto the 5. Chapter.

Or if you had a ſquare péece of red glaſſe placed at the end of the right leg, as Sea-men doe vpon the croſſe ſtaffe, then might you take the Altitude of the ſunne, as you would of a ſtarre, or ſuch other thing: becauſe his beames could not annoy you, be they neuer ſo forcible.

PRO. 4.

Geodeticall Angles of Profunditie.

Profunditas.

Angles of depth, are ſuch as be taken in meaſuring of vallies, welles, or any ſuch other depth; they be but plaine reuerſed Altitudes, as will better appeare when we come to treat thereof. In the taking of them, the left legge ſhould ly parallell, and let him ſtand perpendicular, the end pointing downewards. What ſhould I ſay further? you ſée they be but Viſa verſa, to Altitudes, as I haue ſaid.

Vide lib. 4. cap. 9. & 10.

Chap. V.

The legge of the Geodeticall Staffe, being opened vnto any angle to finde the quantity thereof in degrees.

Gradus.
Circulus.

A degrée in latine called Gradus, is the 360. part of a circle: into which portions, all circles Aſtronomicall, or Geometricall, are imagined to be deuided; and they make choice of that number, becauſe of any ſo little a number, it will be deuided by moſt numbers.

Now for to finde the quantitie of an angle, you ſhall firſt vnderſtand what the quantitie of any Angle is.

Quantitas Angulor.

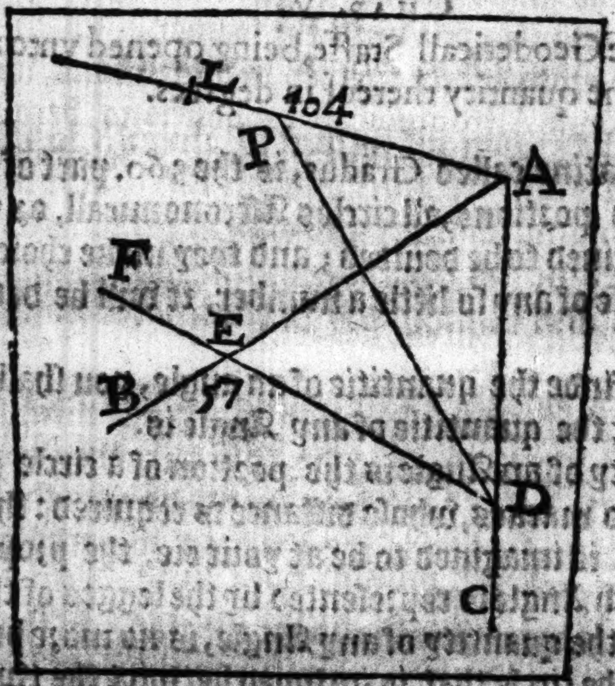
The quantity of an Angle is the portion of a circle included betwixt the two markes, whoſe diſtance is required: the center of which circle, is imagined to be at your eie, the proportion & ſemitry of which Angle is repreſented by the legges of the ſtaffe: ſo that to finde the quantity of any Angle, is no more but to find the portion of the circle that is included betwixt the two points reſpectiue in each legge, which is thus had.

Angulorum quantitatem, calculare.

Place the center of the graduator vpon the Equicurrall ſight in the left legge: then bring the ſame center vnto the point reſpectiue, by the 4. Definition, in the 2. Prop. of the firſt Booke: and by the 7. Definition, turne the degrées of a circle towards the legges, the center of the Graduator ſo reſting, bring the other end of the Graduator vnto the right point reſpectiue: then the degrées cut vpon the Graduator by the ſaid point reſpectiue, is the true quantity of the Angle.

But it may ſo fall out, the Angle being greater then 90. that the Graduator will not reach vnto yͤ point reſpectiue in the right legge: then muſt you note among the degrées, or vnequall diuiſions, in the lower ſide the ſaid right legge, where the very end of the Graduator cuts (the other end reſting at the left point reſpectiue,) which by the 5. Definition, in the 2. Prop. 1. Booke, is the quantitie of the Angle.

Example.



LEt C A B bee an Angle, whoſe quantitie is required, heere placing the Graduator in the left legge A C, at the point reſpectiue D, then mouing the other end of the graduator F, vntill the fiduciall edge cut the point reſpectiue E, in the right leg A B: ſo ſhall you ſee the quantitie of the Angle C A B, numbred vpon the graduator, to be included betwixt the two points reſpectiue D E, videl. 57. degrees, which the right point reſpectiue E. cuts.

But if the feete be opened to the Angle C A M, then the end of the graduator F will not reach to L the point reſpectiue in the right legge A M, therefore moue that end lower towards A, vntill the very apex, or end of the graduator touch among the vnequall diuiſions in the lower ſide of the right legge, as at P, ſo that you ſee the ſaid end of the graduator, among thoſe vnequall diuiſions, point out the iuſt quantity of the Angle C A M, 104. degrees.

CHAP. VI.

To open the legges vnto any Angle propoſed.

BRing the graduator vnto the point reſpectiue, in the left leg: then if your Angle be vnder 90. degrees, bring the point reſpectiue in the right legge, vnto the quantitie of the ſaid Angle in the graduator, ſo is the Angle made: but if the Angle propoſed be aboue 90. degrees by the 3. Deff. in the 2. Prop. Booke 1. ſeeke the ſaid Angle, and thereunto bring the moueable end of the graduator, ſo is the angle made. I will make ſhort of this Chap. becauſe it is but viſa verſa vnto the former.

Before wee proceede any further in dimenſions, wee will lay downe ſome fewe Aſtronomicall propoſitions, becauſe they be deſired by moſt, and make the Staffe more delectable to many.

Chap. VII.

To take the height of the Sun, Starres, Comet, or any other thing aboue the Horizon in the heauens.

By the Altitude of the Sunne or ſtarres, is meant (not as the vulgar imagine, that is to ſay, how farre they are diſtant frõ the center of the earth,) but how many degrees the ſaid Sunne or ſtarre is eleuated aboue the Horizon towards our Zenith, which is eaſily had thus.

De altitudine ſolis, & ſtellarum.

Place the legges vpon the ſide of the ſtaffe, ſo that the left leg lie parallell to the Horizon: then turne the right legge towards the ſunne or ſtarre, as in the 1. Prop. of the 4. Chapter is plainely ſet downe, ſo haue you the angle.

Chap. VIII.

The Altitude of the Sunne being giuen, to finde the howre of the day eaſily.

Hauing taken the Altitude of the ſunne, repaire vnto the Table vpon the outer ſide of the ſtaffe, which Table is alſo ſet downe in the 5. Chap. Booke 1. and there in one of the ſix rowes, vpon the left hand amongſt the moneths, find ẏ moneth, and day of the moneth (or the neareſt thereunto,) and you ſhall vnderſtand that all the moneths from the beginning of Iune to the end of Nouember, haue their daies ſet vnder them from 10. to 10. and all the other moneths from the beginning of December, to the end of May, haue their daies put aboue the moneth, counted from 10. to 10. or there abouts. Hauing found the day of the moneth, note the rowe wherein it ſtands, in which rowe proceede rightwards, going about the ſtaffe, vntill in the Table anſwering thereunto, you finde the degrees & minutes, if there be any of the Sunnes true altitude before taken: and you muſt note, that the letter D in the top of the ſtaffe, and the letter M placed in each Columne, ſtands for degrees and minutes, ſeruing

Horæ inuentio interdiu.

for all the rowes in each Table, as they ſtand vnder the ſaid letters. Now the Sunnes altitude béeing found in the Table agréeing vnto the moneth, and then in the ſaid Table anſwering to the day of the moneth, to finde the howre of the day, looke in the head of the ſaid Table, iuſt ouer the degrées of the ſunnes altitude, if your demaund were before noone, or in the foote of the Table, iuſt vnder the degrées of the ſunnes altitude, if your obſeruation were after noone, ſo will the howre of the day appeare: and héere note, if you cannot finde the iuſt altitude of the ſunne in the Table, take the neareſt by proportion, which by the 28. Chapter, you may worke as neare as you will.

Alſo note in ſome moneths, there be placed the 33.35.34. day of the moneth, as in Iune, Iuly, Auguſt &c. which ſhew in the 3.4. &c. day of the enſuing moneth: as in Auguſt there is placed the 35. day, Auguſt hath but 31. daies, therefore it ſtands for the 4. day of the enſuing moneth, which is September.

Example.

The 12. of Iune I finde the Sunne to be 53. degrées high, and 45. minutes: then reſorting vnto my Table vpon the high outerſide of the Staffe, I finde the ſaid 12. day of Iune, and then procéeding rightwards in the ſame rowe, I find 53. degrées, 45. minutes, anſwering to which, in the top of the Table is 10. of the clocke, and in the foote, two of the clocke: but foraſmuch as my obſeruations were in the forenoone, I conclude it therefore to be 10. of the clocke before noone.

Another Example.

The 16. day of Auguſt, 1606. I finde the Sunne to be 40. degrées high, the neareſt day to the 16. that I can finde, is the 13. day, anſwering to which, in the rowe rightwards, I ſéeke 40. degrées, the height of the Sunne: but foraſmuch as I cannot finde 40. degrées in that rowe, I take therefore the neareſt thereunto, which is 43. degrées, and 11. minutes: then for as much as my obſeruation was after noone, I ſéeke the howre in the foote of the Table, right vnder the degrées of altitude, as before, anſwearing whereunto is two of the clocke after noone.

Now if you deſire to haue the iuſt and preciſe howre of the day, when the iuſt day of the moneth, nor the true degrée of the ſunnes altitude cannot be found in the Table, worke by the 28. Chapter, making proportion according to the difference.

Note, you may make a Cylinder by the foreſaid Table, and place the ſame vpon the backe of your Staffe in ſtéed of the ſaid

Table, and ſo ſaue the ſtamping of ſo many figures,* as you be inſtructed.

* Orontij Finei Delph. horologiorum, lib. 3. pro. 3

Chap. IX.

To take the diſtance of any two ſtarres vnknowne.

Place the legges vpon the top of the ſtaffe, and then reſort vnto the 2. Prop. 4. Chap. of the Geodeticall Angles of Latitude, where this Chap. is performed in all reſpects.

To take the diſtãce of ſtarres.

Example.

I deſire the diſtance betwixt Oculus Tauri, and Canis Maior; working according vnto the 4. Chapter, and 2. Prop. you ſhall finde they be diſtant 46. ½ degrees: ſo and in like manner may you take the length of the taile of any Comet, or ſuch other like impreſſion ſeene in the aire; you ſhall alwaies finde the Comet and the ſunne to be in one great circle, he beeing oppoſite vnto the ſunne, towards whom the taile of the ſaid Comet is extended: from which reaſon, Cornelius Gemma drawes the foundation of his argument, when hee affirmes that there is no fiery Region, and that Comets, &c. are ſet on fire by the onely heate of the ſunne: but the ancient Philoſophers, affirme that a Comet is ingendred in the higheſt Region of the aire, being of a viſcoſious, or groſſe, warme, and ſlimie ſubſtance, apt to nouriſh fire, there kindled by the fiery Region, &c. But I runne heere from my owne intention into a new diſcourſe, therefore I refer thoſe inquiſitiue hereof, vnto Ariſtotle. I haue drawne a Booke of Meteors my ſelfe, not yet Printed.

Cometa.

Cometa quid.

Liber. 1. cap. 4. Meteorologicorũ.

Chap. X.

To finde the howre of Sunne riſing and ſetting, the length of the day and night by the Geodeticall Staffe.

Hauing found the day of the moneth as before, proceeding in that rowe, go round about the ſtaffe rightwards, vntill you come vnto the laſt degrees and minutes of the ſunnes altitude, that is placed there: then ſee what howre is iuſt ouer the head thereof in the howres of forenoone, and that obſerue for the howre of ſunne riſing. The howres in the foote of the Table, iuſt vnder the ſaid degrees, is the howre of ſunne ſetting, or a little after, according to the quantitie of the degrees.

Ortum & occaſum ſolis, nec non arcum eius diurnum & nocturnum, ſiue quantitatem diei & noctis obſeruare.

Then if you double the howres of Sunne-ſet, thereof commeth the length of the day, which if you take from 24. you haue the length of the night, as if the Sunne ſette at 8 of clocke, that doubled is 16. the length of ŷ day, which taken from 24 leaueth 8. the length of the night.

Chap. XI.

To find the Altitude of the north Pole by the ſtarres, as neuer ſet, a neceſſarie Propoſition for Sea-men.

Altitudinem poli agnoſcere diuerſis modis ſub nocte.

Take the Meridian Altitude of the ſaid ſtarre when he is iuſt aboue the Pole, and againe when he is iuſt vnder the pole, right in the Meridian, then adde theſe two Altitudes together, the halfe whereof is the Eleuation of the Pole. In this working there muſt be alwaies iuſt 12. howres betwixt ŷ taking of the two altitudes: for ſo long will the ſtarre be deſcending from the Meridian aboue the Pole, vnto the part of the Meridian vnder the Pole: Now if you take the Eleuation of the Pole from 90. there remaines the Equinoctiall height.

Altitudinem Equinoct. ſupputare.

Cap. XII.

To doe the laſt Chapter another way, by the ſtarres as ſette, or by the Sunne.

First take the Meridian altitude of the ſtarre, then learne the ſtarres declination: if it be North, you muſt ſubduct the ſaid declination out of his Meridian altitude, ſo haue you the Equinoctials height: but if the declination were South, adde the ſame vnto the Meridian altitude, ſo likewiſe haue you the Equinoctials height, which if you take from 90, you haue the Poles eleuation: for the latitude and the Equinoctiall height are alwaies one, the complement vnto the other, both making 90.

Altitudinem poli in die perſcrutari.

As in the night you take the Eleuation by the ſtarres, in the ſelfe ſame manner may you finde the Eleuation in the day by the Sunne: for there is no difference at all, therefore I will make ſhort hereof.

Chap. XIII.

The Latitude of any place beeing found, how to get the declination of the Sunne, or any Planet, Starre, or Comet out of the heauens, by obſeruation.

Take the Altitude of the Starre or Planet, by the 7. Chap. then note whether the ſaid altitude be more or leſſe then the

Equinoctials height: if it be moꝛe then the Equinoctials height, then take the height of the Equinoctiall from the ſaid Meridian altitude, the remainder is the declination of the ſaid ſtarre, which you may conclude to be noꝛth, becauſe the altitude was greater then the Equinoctiall height.

Declinationem ſoli, ſtellarũ, & planetarum elicere.

If the altitude had beene leſſe then the Equinoctiall height, you muſt haue taken it out of the greater: ſo ſhould you haue had the declination, which you muſt haue called ſouth, becauſe the Meridian altitude was leſſe then the height of the Equinoctiall: but you ſhall finde ſome ſtarres as neuer come into the ſouth, foꝛ that they allwaies kéepe vpon the noꝛth ſide of the Zenith. The Meridian altitude of ſuch ſtarres may be twice takẽ, as in the 11. Chapter: foꝛ the declination of theſe, take the latitude out of the greater Meridian altitude, and the remainder frõ 90. ſo haue you the declination: but if you will woꝛke by the leſſe Meridian altitude, take then the ſaid altitude out of the eleuation, and that which remaines out of 90, ſo haue you the declination.

Oꝛ if you take the leſſer Meridian altitude from the greater, and halfe the remainder thereof from 90. the declination alſo appeares: and take this generall to make vp the end of Aſtronomicall matters, that all thoſe ſtarres, whoſe declination is equall to the latitude, being both noꝛth oꝛ ſouth, once in 24. houꝛes, touch our Zenith, and thoſe ſtarres declining fromwards the Pole eleuated, whoſe declination is greater (neuer ſo little) the the Equinoctials height (oꝛ complement of the Eleuation) are neuer ſéene in that country; and in like maner thoſe ſtarres whoſe declination towards the Pole Eleuated, excéedeth the height of the Equinoctiall, doe neuer ſette, as Caſiopæia, Vrſa maior, and minor, with vs doe.

Quæ ſtellæ oriantur, & occidant aut per verticem aut infra horizontem ſemper moventur, manifeſtare.

Such as neuer appeare vnto vs, be Ara, pars equina Centauri. the bottome of the ſhip, and Canopus, with the Croſſe and Triangle to Conſtellations newly found out, the béing whereof is doubted of many.

Let this ſuffice foꝛ matters Aſtronomicall at this time, hereafter it may be, I ſhall be occaſioned to ſpeake further: now we will onely haſte to the Geodeticall vſe of the ſtaffe, foꝛ to finde the pꝛalax of Comets, Planets, &c. and the diſtance from the center of the earth, is eaſie.

Caap. XIIII.

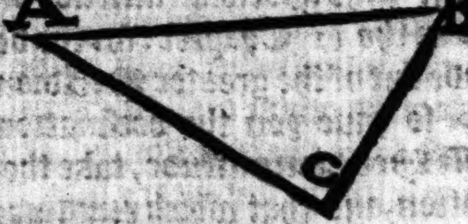
Of the diuerſitie of Geometricall Triangles.

Diuerſitie of Tryangles.

By the diuerſitie of Triangles, is not meant in reſpect of their quantitie, according as they be greater or leſſer: but in reſpect of the ſides or Angles that be giuen or required: for in all Geodeticall menſurations, you ſhall haue but two lines, and one Angle, or two Angles, & one line giuen, the other vnknowne lines and Angles be ſought for, and may happen diuerſe waies.

Situs angulorum & linearum rectarum.

1 You may haue two knowne angles to ſtand at the end of a line knowne, as A B C, and B C A, at the ends of the line C B, knowne, as in the 15. Chap. or 30.



2 Or one of the Angles knowne, may be ſcituate at yͤ end of a line knowne, as C A B, at the end of A B the line knowne, and the other angle may ſtand at the end of a line vnknowne, as A C B at the end of A C an vnknowne line, as in the 18. and 19. Chapter, or 32.

3 For the ſecond difference, where you haue two lines and one angle giuen, thus may they be ſcituate, either both yͤ lines knowne may containe the angle knowne, as C B and C A, doe the angle A C B, as in the 32. Chapter.

Vide chap.34.

4 Or elſe the one line knowne, may be the ſide of the angle knowne, as A C is to the angle A C B, & the other line knowne, may ſubtend the angle knowne, as A B doth the angle A C B, & this is the greateſt diuerſitie that may happen in any dimenſion vpon the ſtaffe, as in the 33. Chapter.

Chap. XV.

If a Caſtle, Fort, or armie of men, &c. be ſeene farre before you, how to fetch the diſtance of them from you with great ſpeed, and facilitie, without Arithmeticke,

Propoſitio.

Vide chap.30.

Two Angles knowne, being ſcituate at the ends of a line knowne, to find the quantitie of the 3. Angle, and the other two ſides vnknowne.

Eu.32.p.1.
Ra.9.cl.6.

It is a common receiued ground amongſt all Geometricians, that in all Triangular figures, the third angle is taken together,

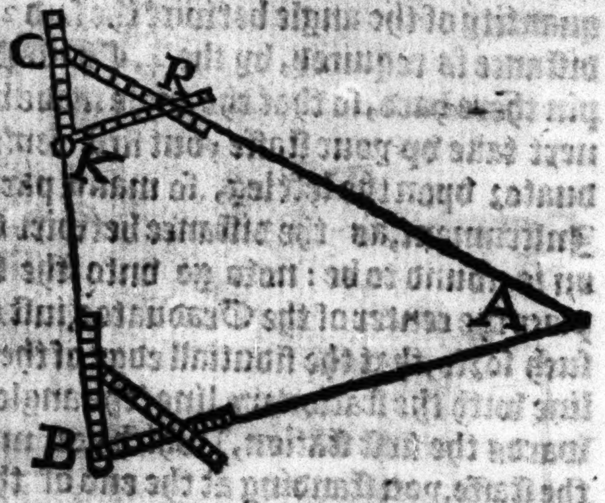
ther, are equall vnto two right angles, and two right angles make 180. degrées of a circle; therefore ſubtract the two knowne angles from 180. the remainder is the quantity of the 3. angle. Now for the diſtance of ſides of Triangles, worke thus: hauing a place aſſigned, whoſe diſtance is required, appoint two ſtations in a knowne diſtance from you, then go vnto the firſt ſtation, and tourning the left leg towards the ſecond ſtation, take yͤ quantity of the angle betwixt the ſaid 2. ſtations, & marke whoſe diſtance is required, by the 4. Chap. Prop. 2. Wreſt the center pin there hard, ſo that the angle made by the legs be not altered: next take vp your ſtaffe; but firſt remoue the center of the graduator vpon the left leg, ſo many parts from the center of the Inſtrument, as the diſtance betwixt the firſt and ſecond ſtation is found to be: now go vnto the ſecond ſtation, and there place the center of the Graduator, iuſt ouer the ſaid ſtation, in ſuch ſorte, that the fiduciall edge of the left leg may lie in a right line with the ſtationary line (the angle before made looking frōwards the firſt ſtation,) which you may eaſily doe, by mouing the ſtaffe, you ſtanding at the end of the left legge, vntill by the center of the graduator, and the center pin of the Inſtrument, you ſée the firſt ſtation: but you muſt haue a ſpeciall care not to alter the angle made vpon the legges at the firſt ſtation: this done, turne the moueable end of the graduator which lyeth vpon the right legge (but not ſtirring the center from his place) vntill the fiduciall edge thereof, point iuſt vnto yͤ marke, whoſe diſtance is required, this being done, you haue your deſire: for the equall parts betwixt the center of the graduator, and the inſtrument, is the diſtance betwixt your two ſtations, and the parts cut by the fiduciall edge of the graduator vpon th [illegible] legge, is the diſtance of the marke from the ſec [illegible] right [illegible] ſtation, and the equall parts of the graduator cut [illegible] the right legge, or ſo many parts of the graduator, as [illegible] included betwixt the right & left legge (for all is one) [illegible] the iuſt diſtance of the 2. ſtation from the marke deſired, in ſuch parts of meaſure as you expreſſed your ſtationary line by, ſo haue you the two vnknowne ſides of the Tryangle.

Longitude.

Example.

Let A B be a diſtance, A a Tree, B your ſtation from whence you deſire the true diſtance of the trée, appoint C for the ſecond ſtation on the left hand, and there ſet vp a viſible marke: now take the quantitie of the angle A B C by the 4. Chapter, Prop. 2.

which let be 75. degrées, then count the length of B C upon the left legge from the center, which let be 40. pearches, whereunto bring the center of the graduator, then take up the ſtaffe, and go unto the ſecond ſtation C, over which place the center of the graduator, then turne the left leg K M, untill the center of the graduator C, and the center of the inſtrument K point iuſt to B the inſtru: ſo reſting, remoue the end of the graduator O, untill the fiduciall edge thereof C & O point iuſt to A; ſo is there 55. pearches betwixt C and A: for that there be ſo many equall parts included betwixt ẏ left foote K M, and ẏ right foote K R upon the graduator, then the graduator cuts the right foote at R, which is 49. parts, and ſo many pearches is B from A. So you ſée wée haue made a Tryangle upon the legges, as K C R equall and proportionall unto B C A, whereunto we might inferre proportionall termes, with the Geometricall demonſtration, which we will reſerue for another place.



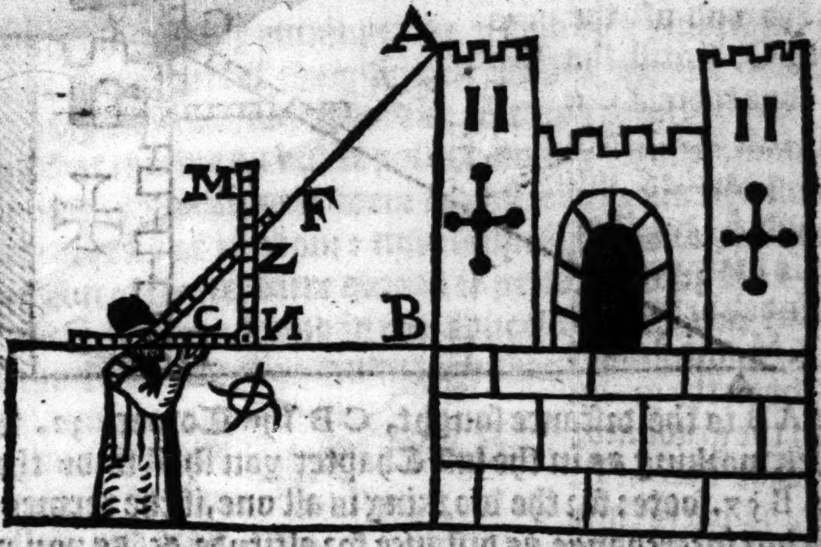
Chap. XVI.

To take the height of any Caſtle, Tower, Tree, &c.

Altitudo.

FOraſmuch as all altitudes ſtand perpendicular, and therefore make right angles with the line of leuell, by occaſion whereof, you ſhall néede to ſéeke but one angle and one line, for that the ſecond angle is before hand knowne to be right.

Take therefore the diſtance from your ſtanding, unto the baſe of the thing whoſe altitude is required, this done, open the legs unto a right angle, & then place them upon the ſide of the ſtaffe, ſo that the left legge lie parallell to the Horizon, next remoue ẏ center of the graduator, to ſo many parts of the left legge, as the baſe of the foreſaid altitude is diſtant from you, then heaue up, or put downe the other end of the graduator, untill the fiduciall edge thereof agrée with the ſummite or toppe of the altitude; the parts then betwixt the graduator and the center, counted vpon the right legge, is the altitude of the thing required, and the parts of the graduator included betwixt the two legs, is the diſtance of the toppe of the altitude to your note, wherby you may finde the length of any ſcaling ladder.



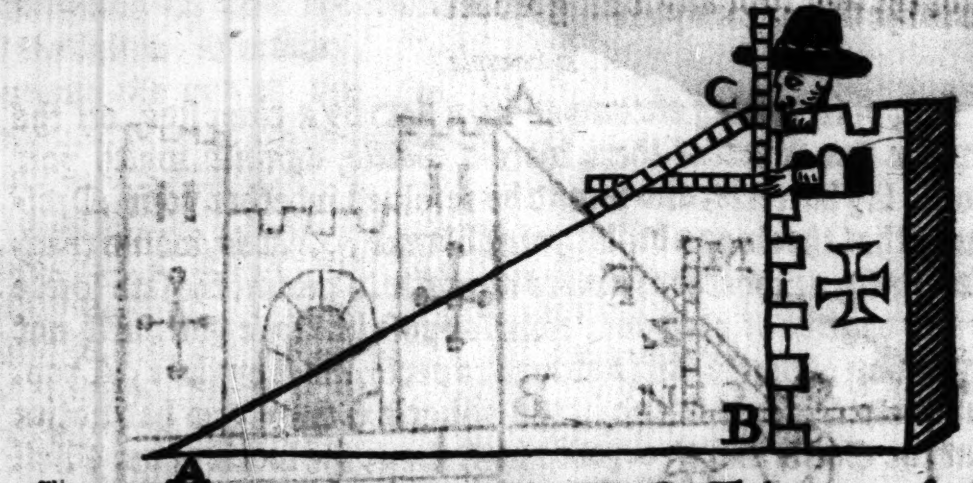
Let N A B be a height, B C the diſtance, 27. $\frac{1}{2}$ yards, therefore I remoue the center of the graduator C, 26. $\frac{1}{7}$ equall parts towards N, videl. to C, then I open the right legge N M to a right angle on M, then I heaue vp the other end of the graduator F, vntill the point iuſt to A, ſo will he cut 29. parts at Z vpon the right legge M N. I conclude therefore briefly, that A B is 29. yards high: and forasmuch as there be 39. equall parts counted on the graduator C F, betwixt the two legges M N, and N O: I therefore affirme the length of the Hipothemſall line C A to be 39. yards, and ſo long muſt the ſcaling ladder haue beene.

Chap. XVII.

You ſtanding vpon a Cleffe, Tower, or Rocke, & to tell how farre any thing ſeene before you, is diſtant from you.

Open the legges to a right angle, and then place the right legge to lie parallell, ſo ſhall the left leg point iuſt to the Zenith, now meaſure how high the Tower wheron you ſtand is, according to which height, place the center of the graduator in diſtance from the center of the inſtrument, the legs ſtanding as before, and the right angle not altered, moue the other end of the *Longitude.*

graduator, vntill by the fiduciall edge thereof, you ſee the marke whoſe diſtance is required. The parts then vpon the right leg, intercepted betwixt the graduator, and the center of the Inſtrument, is the true diſtance of the marke whoſe longitude was ſought.



Here A B is the diſtance ſought, C B the Tower, 32. foote high; then working as in the laſt Chapter you ſhall finde the diſtance A B 57. foote: for the working is all one, if the termes of arte doe but interchange, as diſtance for altitude, &c. as you may eaſily perceiue by the letters in each demonſtration, or figure. Note that in the former, and alſo in this Chapter, you might haue taken away the graduator, and onely worked by the left ſight, vnleſſe you had required the hypothenuſall line, as in the next Chapter will appeare.

Chap. XVIII.

The height of a Fort, Caſtle, Tower, or ſuch like giuen, to fetch his diſtance from you by onely taking his angle of altitude.

Propoſitio.

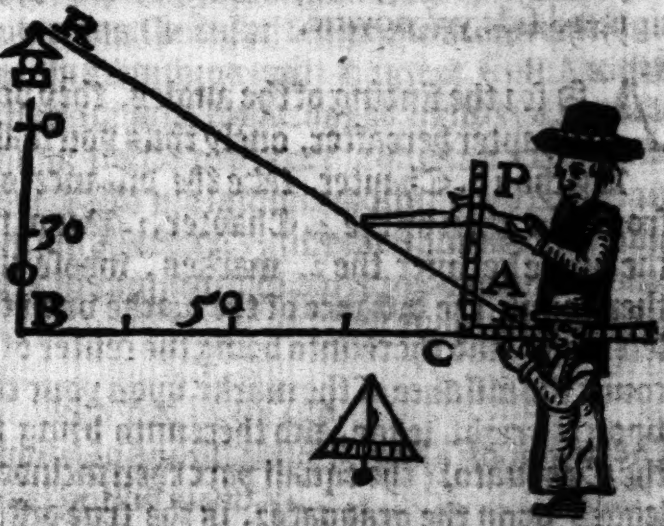
Two knowne angles of a Tryangle, being ſcituate, the one at the end of a line knowne, and the other oppoſite to the ſaid line, to finde the other angle and two lines vnknowne.

Longitudo. YOu be taught in the 15. Chapter, to finde the quantitie of ye third angle, and for the lines worke thus.

Open the legges vnto a right angle, and then turning the center of the inſtrument towards the height, place the left leg to lie parallell, and the right to point iuſt vnto the Zenith: now remoue the ſight in the right legge, ſo farre from the center as the height of the thing inſtructs you, the right ſight reſting there, draw backe the ſight in the left legge, vntill he be in a right line with the ſummite of the altitude, and ſight in the right leg: then ſo farre as he is from the center, that is, ſo many equall parts as be included betwixt him and the center, ſo many pearches; ſcores &c. is the thing from you.

Example.

Suppoſe you lay encamped in a field by a riuer ſide, on the further ſide whereof there were a Caſtle, againſt which you would lay batterie, and would be reſolued whether your Ordinance that throwes a bullet point blanke 50. yards, would reach thereunto, or whether it were requiſite to mount the ſaid Péece to any degrées of random: now ſuppoſe likewiſe you durſt not (by reaſon of ſhotte) ſtirre abroad to performe it by the 15. Chap. but onely by ſome friend in the aduerſe Camp, you had notice that the Caſtle were 30. yards high aboue the leuell of vs. Well then procéede thus.



Place the left legge C D to lye parallell, and then remoue P C the right legge to a right angle: now for that B R is 30. yards high, I place the ſight A in the right legge C P, 30. equall parts from C, thē I draw backe F yͤ ſight in the left legge C D, vntill by F and the ſite A, I ſée the top of the Tower R: ſo that F A R lye all thrée in a right line, then I count the equall parts betwixt F and C, and find them to be 50: ſo then I may conclude, that it is iuſt 50. yards to the Caſtle, and that the péece of Ordinance will beare a bullet thereunto point planke.

Chap. XIX.

The laſt Chapter performed by the Author another way.

Or thus, you may apply the laſt Chapter. Suppoſe you had a Péece of Ordinance that would carrie point blanke 50.

yards, and that you were vpon a preſent occaſion to place him to endanger the aduerſarie, heere remoue the ſight in the right leg to 30. the height of the Tower (as before) and then draw backe the ſight in the left legge to 50. the length that the Peece will carrie: now cauſe the Peece to be drawne after you, you going direct towards the Tower, and bearing the left legge (as before parallell) vntill by the ſites in both the legges, you ſee the very top, and there may you ſurely plant your Peece, ſo that hee ſhall throw the bullet full point blanke vpon the Caſtle.

Chap. XX.

You ſeeing two ſhippes vpon the ſeas, or two Caſtles, Towers, Trees, or ſuch like vpon the land, to ſeeke the diſtance thereof without Arithmeticall calculation.

Propoſitio.

One angle, and two ſides of a Tryangle beeing knowne, which containe the angle knowne, to finde the other two angles, and third ſide vnknowne.

As for the finding of the angles, they bee taught in the 33. Chapter hereafter, onely thus you ſhall find the third ſide. By the 15. Chapter, take the diſtance of the two Towres from you, then by the 4. Chapter, 2. Prop. take the quantitie of the angle betwixt the 2. markes, whoſe diſtance is required: then count the diſtance of the marke vpon the left hand, on the left legge, and thereunto bring the center of the graduator; then count the diſtance of the marke vpon your right hand from you, vpon the right legge, and thereunto bring the fidutiall edge of the Graduator; the equall part then included betwixt both the legges vpon the graduator, is the true diſtance ſought.

Example.

Let C A in the figure of the 15. Chapter, be to marke whoſe diſtance is required, let B be your ſta. firſt I take the diſtance of C B, and finde it to be 40. pearches, then of A B, and finde it to be 49. pearches, which noted, I take the angle A B C, then I count 40. vpon the left legge, and thereunto bring the center of the graduator, then I count 49. on the right legge, where I lay the fidutiall edge of the graduator: ſo then there are 55. equall parts vpon the graduator cut by the right legge, which I pronounce for the true diſtance of C A.

Chap. XXII.

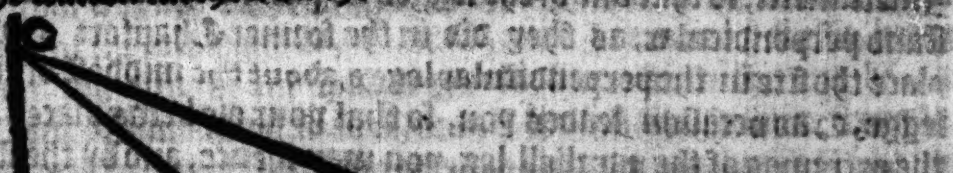
A Caſtle, Fort, Towre, or ſuch like ſeene before you, ſo that by reaſon of diuerſe impediments, you cannot take his diſtance from you by the 15. Chapter, how to performe it heere by the helpe of two ſtations, though you cannot diſcerne the baſe or any part thereof, but ſome pinnacle or ſuch like; nor go ſidewiſe, but ſtraight forwards or backwards.

Propoſitio.

Si Triangula ſunt equiangula ſeu ſimilia, cruribus homologis proportionalia, & contra.

Eu.45.6.&7. Prop.

Open the legges vnto a right angle, and then take away the graduator, placing both the ſites in the left leg, this done, go as neare vnto the Towre as you will, or place the lower ſight in the left legge at ſome euen number vpon the legge, going to and fro, or ſtirring the ſaid ſite vntill the extremes of the end of the right legge, and the foreſaid ſight agree with the very ſummite of the altitude, keeping the right legge parallell, the ſite reſting ſo, remoue the other ſite ſome euen number from the firſt placed ſite, going fromwards or towards the marke, as occaſion ſerueth, vntill you ſee the ſummite of the altitude: againe by the end of the right legge and the laſt placed ſite, the ſites ſo reſting, meaſure the diſtance betwixt your two ſtations, and note how many euen parts be contained betwixt your two ſites vpon the left legge: for ſo many times as thoſe euen parts be contained betwixt the vppermoſt ſite, and the center of the Inſtrument, ſo many times may you ſafely conclude the diſtance betwixt your two ſtations, to be contained betwixt the Towre, & the ſtation furtheſt off the ſaid Towre.



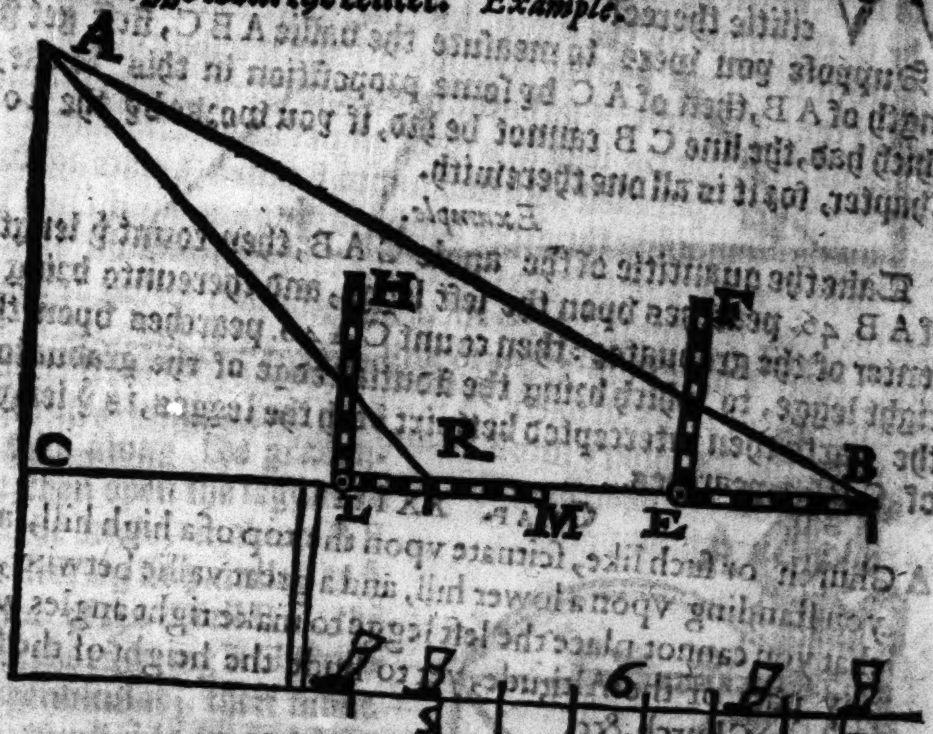
Suppoſe the diſtance of A B is required, now by reaſon of woods and hilles you can ſee nothing but the top thereof C; well then, I open the legges of my inſtrument vnto a right angle, and appoint my firſt ſtation at D: the right legge lying parallell, I place my eie at the end there of E, remouing the ſite in the left legge D F, vntill he be in a right line with C E, which falleth out to be in the toppe of the legge at F: ſo if you could meaſure the diſtance of B E, you had the altitude B E (as it falleth out here) but for that I cannot, I go backe to G, and there I appoint my 2. ſtations, kéeping the legs at a right angle (as before) and the right legge G A, parallell pointing iuſt to B: then I place againe my eie at A, remouing the other ſite vntill he be in a right line w C A, as at I, then I note how farre I the ſecond ſite is off H my firſt ſite, and I finde it 96. equall parts (the ſiete being 2. foote long) then I note how often that is to be found betwixt H G, which hath 192. equall parts, I finde it is twice there, therefore meaſure the ſtationary line E A, and it ſhall be twice ſo farre frō A to B A as 35. pearches, therefore A B is 70. pearches, which is twice ſo much as 35.

CHAP. XXII.

To take the altitude of a Caſtle, Steeple, Towre, Tree, or ſuch like, where you dare not by reaſon of ſhotte, or cannot by occaſion of waters, &c. come neare vnto the baſe thereof, according to the 16. Chapter, without Arithmeticall calculation.

Altitudo.

Open the legges vnto a right angle, then go towards the baſe of the altitude (ſo it be not ouer neare) there plant your Inſtrument, ſo that one of the legges lie parallell, and the other ſtand perpendicular, as they did in the former Chapter: Now place the ſite in the perpendicular legge, about the middeſt of the legge, or as occaſion leades you, ſo that your eie being placed at the extremes of the parallell leg, you may thence, and by the ſite in the perpendicular legge, ſee the ſummite or toppe of the Altitude required; this done, bring the ſite in the leuell legge, from the end towards the center, a certaine diſtance, as 3. quarters, halfe a quarter, or iuſt ſo much as the ſite in the perpendicular leg is from the center: let the ſites and right angles all ſtand fixed, then chooſe you a ſecond ſtation (going towards the wall) vntill you ſee againe the toppe of the Towre by both theſe laſt fixed ſites (ſtill kéeping the foreſaid legges, the one parallell, the other perpendiculer.) Laſtly meaſure the diſtance betwixt your two ſtations, that is betwixt the places where your feete did ſtand at time of obſeruation, and the ſame diſtance ſhal be either the third part, the halfe the quarter, or iuſt the height you ſought, according as you did place the ſite in the leuell legge, the third part, halfe the quarter, or whole length of the ſite in the perpendicular legge from the center. *Example.*



I place the left legge to lie parallell, and the right perpendicular at E, making E my firſt ſtation, E D the left legge, E F the right: then I draw G the ſite downe from F towards E, vntill he be in a right line with D A, viz. at G, which falleth out in the middeſt of the right legge E F, then I make a marke vnder the end of the left legge D, viz. at O, next I remoue yͤ ſtaffe, bringing the ſite in the left legge ſo farre from the end M, as G was from E, that is to K, ſo is K the left ſite ſo farre from M, as I is from L: then I go toward the altitude, vntill K I be in a right line with A, as D G was before, then I make a marke iuſt vnder K at S, then I meaſure the diſtance betwixt S O, & finde it 6. pearches. I concluſe, becauſe K M is iuſt as much as H I, or F G, that S O is iuſt ſo much as the height A C, S O is 6. pearches, therefore A C is 6. pearches high, * ſo that ſuch proportion as K M hath to H I, the ſame hath S O to the altitude C A, ſo may you worke by the 29. Chapter.

*Vide Chap. 36.

Note, in all theſe dimenſions you fetch ſo much of any height as is aboue the leuell of your eie: for if you would know B A, you muſt adde K S or D O thereunto.

Chap. XXIII.

To meaſure any vallie of ſuch like profunditie.

WEe will make ſhort of this Chapter, becauſe of the facilitie thereof.

Suppoſe you were to meaſure the vallie A B C, firſt get yͤ length of A B, then of A C by ſome propoſition in this Booke, which had, the line C B cannot be hid, if you worke by the 20. Chapter, for it is all one therewith.

Example.

Take the quantitie of the angle C A B, then count yͤ length of A B 46. pearches vpon the left legge, and thereunto bring yͤ center of the graduator: then count C A 40. pearches vpon the right legge, to which bring the fiduciall edge of the graduator, the parts then intercepted betwixt both the legges, is yͤ length of C B 43. pearches.

Chap. XXIIII.

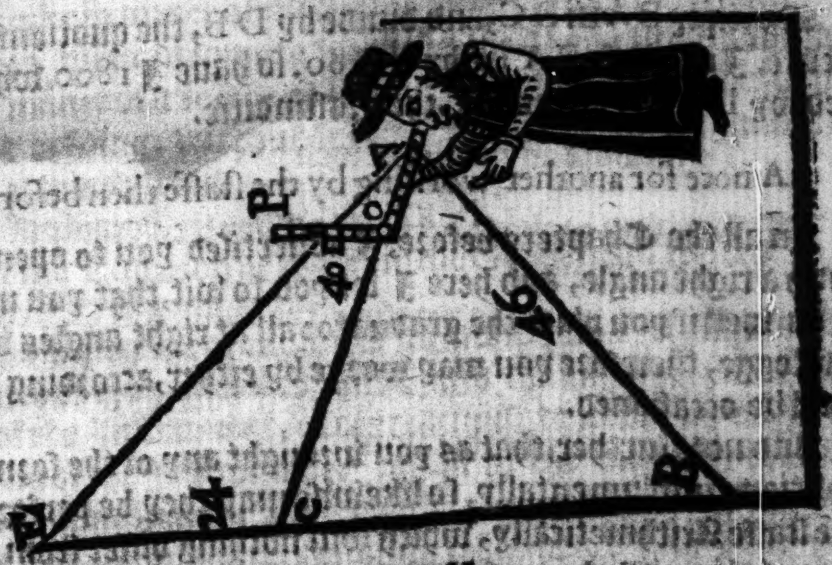
A Church or ſuch like, ſcituate vpon the top of a high hill, and you ſtanding vpon a lower hill, and a great vallie betwixt, ſo that you cannot place the left legge to make right angles with any part of the Altitude, yet to finde the height of the ſaid Towre, Church, &c.

FIrſt get the length of the line A C in the laſt figure, then by the Chapter, get the quantity of the angle A C B, then take the ſaid quantitie from 180. ſo haue you the quantitie of the angle E C A;* then open the legges vnto the quantitie of the ſaid angle C by the 6. Chapter, next count the line C A vpon the left legge from the center, and thereunto bring the ſite or center of the graduator, then make the fiduciall edge of the ſaid left leg to lie in a right line with A C: then placing your eie at the ſite in the left leg, heaue vp or put downe the other end of the graduator, or the ſite in the right legge, if the graduator bée away, vntill the two ſites be in a right line with the ſummite; the part then betwixt the ſite in the right legge and the center, is the altitude required: ſo may you doe by a Caſtle ſtanding vpon a high rocke by the ſea ſide, and you in a ſhippe farre below.

*Eu. 13.14.p.1. Ra.1.conſ.8. &.5.

Example.

A C is 40. pearches, and ſo working as before, you ſhall finde C E 24. pearches, as is plaine by the figure, without the multiplicitie of words.

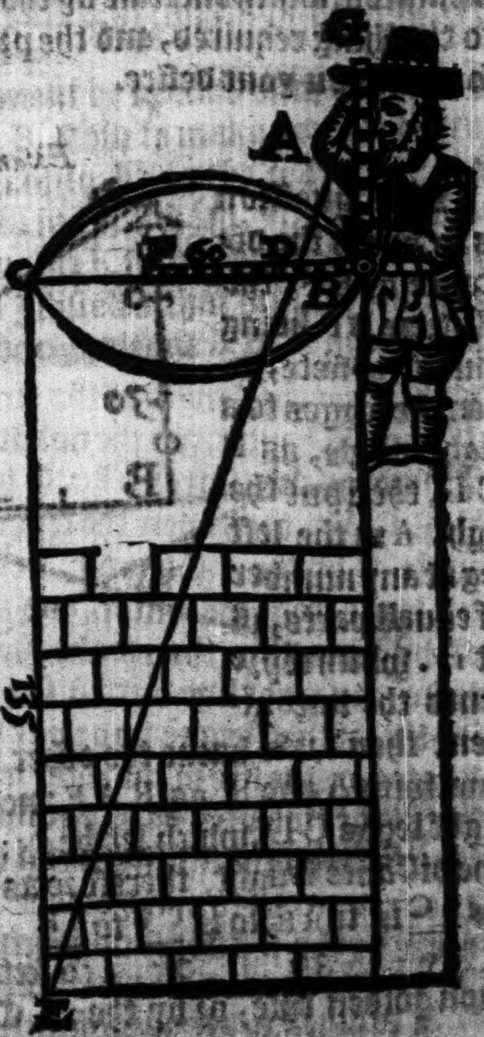


Chap. XXV.

To take the profunditie of any Well, or ſuch like.

Profundities. See the 4. Book Chap, 10, 11. & 12.

In this worke, you may take away the graduator, then open the legges to a right angle, making B F the left leg lie parallell to ÿ toppe of the Well B C, thē ſhall the right leg B G ſtand perpendicular; then moue the two ſights in each leg, as A & D, vntill your ſight paſſing in a right line by both thoſe ſights concurre iuſt with the point E ÿ bottom of the Well, then ſhall you note the equall parts on each legge, where both the ſites ſtand, let D ſtand at 11. and A at 30. laſtly meaſure B C, which let bee 60. now to ſeeke the profundity or length of C E, worke thus.



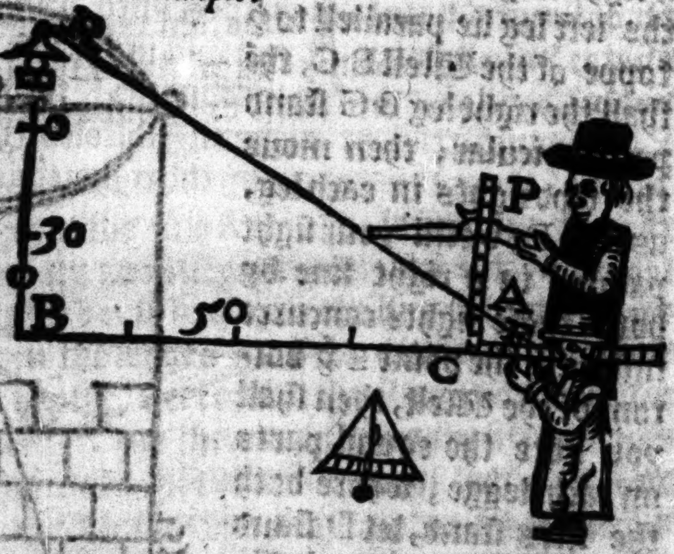
Multiply B A in B C, and diuide by D B, the quotient is your deſire; I encreaſe B A 30. by B C 60. ſo haue I 1800. which parted by D B 11. yeelds 135. the profunditie.

A note for another working by the ſtaffe then before.

In all the Chapters before, I aduertiſed you to open the leg vnto a right angle, and here I let you to wit, that you may doe it as well if you place the graduator all at right angles with the left legge, therefore you may worke by either, according as you ſhall be occaſioned.

And note further, that as you wrought any of the former propoſitions inſtrumentally, ſo likewiſe may they be performed on the ſtaffe Arithmetically, which will nothing differ from the nature of the 5. Booke, and therefore I haue heere let it paſſe: for conſider what part of your ſtaffe doth correſpond with the thing meaſured, which encreaſe by thoſe parts of the legges anſwering to the thing required, and the product part by the line meaſured; ſo haue you your deſire.

Example.



The queſtion is to know the diſtance of B F, the altitude B R being giuen 30. feete, open the legges to a right angle, as P C D, then put the ſight A in the left leg at any number of equall parts, as at 15. which repreſents the line giuen: then draw backe the other ſight, vntill hee bee in a right line with A and R, as R A F: note the parts, cut them by F on ẏ right legge C D, which let be 25; ſo doth C D correſpond to B F the diſtance ſought, therefore as $\frac{AC}{15}$ is to $\frac{CF}{25}$, ſo is $\frac{RB}{30}$ to $\frac{BF}{50}$, or as $\frac{AC}{15}$ is to $\frac{RB}{30}$, ſo is $\frac{CF}{25}$ to $\frac{BF}{50}$ feete. Worke therefore by the cōmon golden rule, or by the 28. Chapter.

To worke in maner of the Sector by the Geodeticall ſtaffe.

Before wee can come to worke by the Geodeticall ſtaffe after the maner of a Sector, it is moſt requiſite to vnderſtand the Chapter enſuing, without which, things hereafter cannot ſo well be attained vnto.

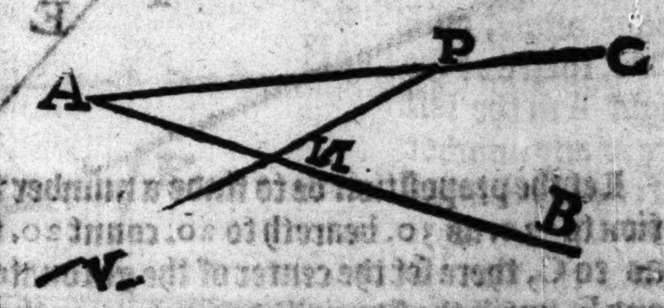
Chap. XXVI.

Of the Equation of angles in the Geodeticall ſtaffe.

BY the Equation of angles, is meant to make an angle at the center of the graduator equall vnto the angle propoſed at yͤ center of the Inſtrument, or contrariwiſe to make an angle at the center of the Inſtrument, equall to the angle at the center of the Graduator, both which are performed after one and the ſelfe ſame maner, therefore when henceforth I bid you make Equation, remember that thereby is meant the making or reequating of an angle at the center of the graduator, equall to the angle at the center of the Inſtrumẽt, or cõtrary, as before.

Example.

Let the legges of the Inſtrument be opened vnto an angle of what quantitie you wil, as C A B. Now to make one at the center of the graduator equall thereunto, bring the center of yͤ graduator vnto what point you will in the left leg, viz. to P, then moue the other end of the graduator K to and fro, vntill A N and P N be equicurrall, or make an Iſoſceles, that is to ſay, vntil the parts of the graduator cut by the right legge A B, be equall vnto the parts of yͤ right leg cut by the graduator, and ſo will there bee as much diſtance betwixt yͤ center of the graduator P, & the place where he falles on the right legge, as there is betwixt the center of the legges and the graduator, counted on the right leg, viz. to N; and ſo haue you made the angle N P A equall to P A N, as may be proued.



Ra.lib.6,10.Pro.

And ſo muſt you worke if the angle made at the center of the Inſtrument be required to be made equall to the angle at yͤ center of the graduator, onely you muſt keepe the graduator at one ſtay, as you did the right legge, and moue the right legge as you did the graduator.

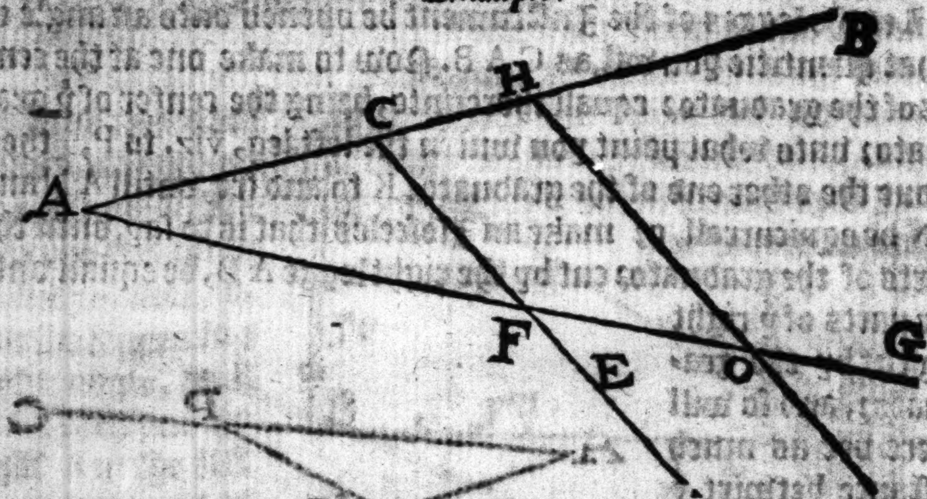
CHAP. XXVII.

Two numbers being giuen, or two lines aſſigned, to find the third in proportion.

Duobus numeris datis, inuenire tertiam proportionalem.

OPen the legges to any angle what you will, then on yͤ left leg count the leſſer of the numbers or ſhorter of the lines, whereto bring the center of the graduator; then count the greater number on the right legge, and thereunto bring the fiduciall edge of the graduator, he reſting at that angle, wreſt the ſcrewe at the center of the graduator ſtrait, ſo that the ſaid angle be not altered: then count the greater number vpon the left legge, and thereto draw the ſocket and center of the graduator, not altering the angle; ſo ſhall the parts cut by the graduator vpon the right legge, be the third number or line in proportion.

Example.



Let the propoſition be to finde a number to beare ſuch proportion to 30. as 30. beareth to 20. count 20. from A towards B, as to C, there ſet the center of the graduator, remoue the other end E, vntill the fiduciall edge cut 30. in the right legge A G, as at F, then wreſt the ſcrew at C hard, ſo that you doe not alter yͤ angle A C F, next count 30. vpon the left legge A B, and thereto draw the center of the graduator, as to H: ſo ſhall the fiduciall edge of the graduator cut the right legge at O, & the parts there cut ſhall be in ſuch proportion to 30. as 30. is to 20. which you ſhall finde to be 45, as may be proued * in ciuill affaires.

* Eu. 2. pro. 6. & 17. Prop. 11.

And thus may you apply this Chapter: if 20. horſes eate 30. buſhels of oates in a day, what ſhall 30. eate in a day? and you ſhall finde 45.

Chap. XXVIII.

To performe the Golden number, called the Rule of 3. or rule of Proportion, where you haue three numbers giuen, and be required to finde the fourth in proportion.

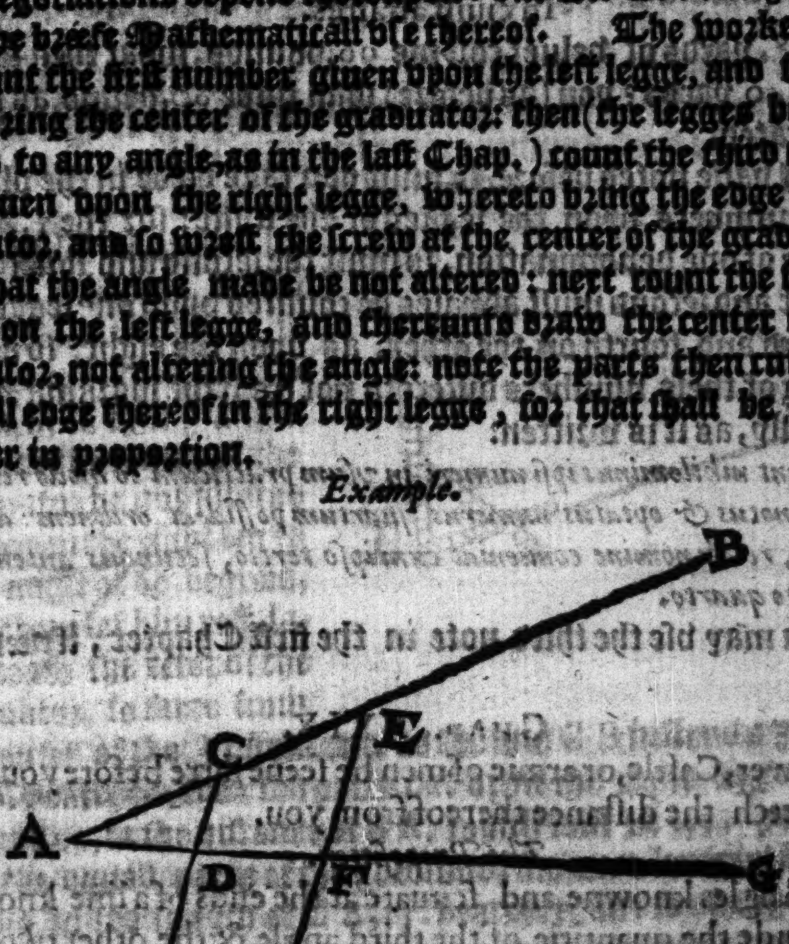
De poteſtate 4. numerorum proportionalium,

This rule of 3. is ſo called, for that as much as by 3. proportionall numbers knowne, it alwaies findeth out yͤ fourth, and is of ſuch force, that well-nie, all as well ciuill as Mathematicall negotiations depend thereupon: but wee will onely open it for the breefe Mathematicall vſe thereof. The worke.

Count the firſt number giuen vpon the left legge, and thereunto bring the center of the graduator: then (the legges beeing opened to any angle, as in the laſt Chap.) count the third number giuen vpon the right legge, whereto bring the edge of the graduator, and ſo wreſt the ſcrew at the center of the graduator hard, that the angle made be not altered: next count the ſecond line vpon the left legge, and thereunto draw the center of the graduator, not altering the angle: note the parts then cut by yͤ fiduciall edge thereof in the right legge, for that ſhall be the 4. number in proportion.

Eu.lib.6.Pro.12

Example.



Let the propoſition be, if 48. giue 96. what ſhall 40. giue? Firſt count 48. in the left legge A B, and where that number ends, bring thereto the center of the graduator, as to C: then count the third number giuen (which muſt alwaies be of the ſame denomination as the firſt) vpon the right leg A G, which is 40. whereunto bring the edge of the graduator C D, as to D: next count the ſecond number giuen, that is 96. vpon the leg A B, and where it ends make the point E, whereunto bring the center of the graduator, not altering his angle: ſo ſhall the frontall edge thereof, cut the right leg A G at the fourth number in proportion, viz. at F, which is 80, bearing ſuch proportion to D, as E doth to C.

To apply it Geodetically.

If 48. inches, giue *96*, what ſhall 40. inches giue? and you ſhall finde 80. as before, the height ſought for.

In ciuill affaires.

E.19. *Pro.lib.7.* If 48. yards of veluet coſt me *96*. pounds, what then ſhall I pay for 40. yards? you (as before) ſhall finde 80. pound, as is demonſtrated.

Conditio regulæ animaduertẽda. As I haue noted before, ſo muſt you take heede in the placing of the numbers vpon the legges of the ſtaffe: for the 1. and 3. muſt be of one denomination, ſo muſt the ſecond and fourth, and the firſt and ſecond muſt alwaies be counted vpon one legge, and the third and fourth on the other, as vpon the eight, ſo as the placing of theſe numbers differeth not from the working Arithmetically, as it is written:

Orontius lib.3. cap.4. De Arith. Pract. *Debent nihilominus ipſi numeri, in vſum practicum eo modo reuocari, vt ignotus & optatus numerus quartum poſſideat ordinem: ac ipſe primus, re & nomine conueniat cum ipſo tertio, ſecundus autem cum acquiſito quarto.*

You may vſe the third note in the firſt Chapter, if neede be.

CHAP. XXIX.

If a Tower, Caſtle, or armie of men be ſeene farre before you, how to fetch the diſtance thereof from you.

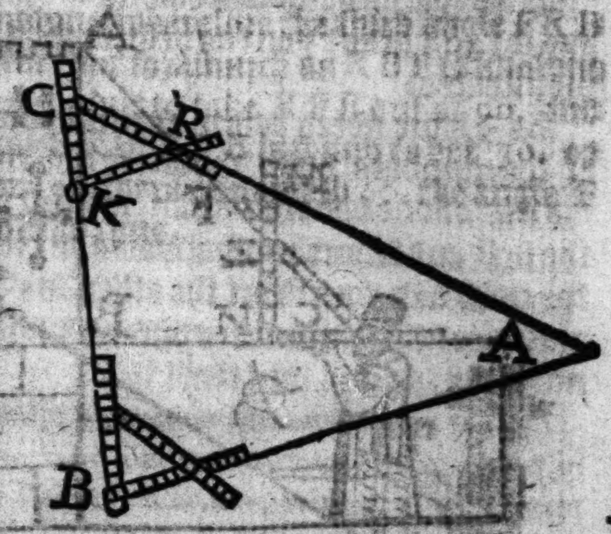
The Propoſition.

Two Angles knowne, and ſcituate at the ends of a line knowne, to finde the quantitie of the third angle, & the other two ſides vnknowne, in any Tryangle.

Longitude. As in the former working by the ſtaffe, of neceſſitie you performed euerie Propoſition before you could remoue the ſtaffe, ſo in this kind of working may you doe; notwithſtanding it reſts at your pleaſure ſo to doe, or onely take the angles, and performe the reſt at your beſt leaſure. I will make ſhort hereof, let A be a trée whoſe diſtance is required, B your firſt ſtation, and C your ſecond; firſt, by the 4. Chapter, Prop. 2. take the angle C B A, which is 79. degrées, note that done, then take yͤ angle B C A, which is 60. degrées, note that done: laſtly meaſure the line C B (which I call your ſtationary line, becauſe it is included betwixt your two ſtations) and you ſhall finde it 40. pearches, and note that done, ſo haue you two angles and one line: now to finde the third angle, and the other two lines, worke thus.

Adde the two angles together, that is 79. & 60. which makes 136, which take from 180. ſo haue you the quantitie of the third angle 44. degrées, as is proued: then for the two ſides, B A, and C A, worke thus.

Chap. 15.



By the 6. Chapter, open the legs to the quantitie of the angle C B A, which is 79. degrees, then make equation by the 26. Chapter, which done, wreſt the ſcrew at the center of the graduator hard, ſo that yͤ angle made at the center of the graduator be not altered then open the right leg to the * angle of 60. degrées, and there let him reſt, laſtly draw the cẽter of the graduator, ſo farre from the center of the Inſtrument as the line C B inſtructs you, that is 40. pearches; then the parts cut upon the right legge by the graduator, is the diſtance of B A, which will be 49. pearches, and the equall parts of the graduator included betwixt both the legges, is the length of C A, 55. pearches, and ſo of any other.

*Vide lib, 6. Cap, 13.

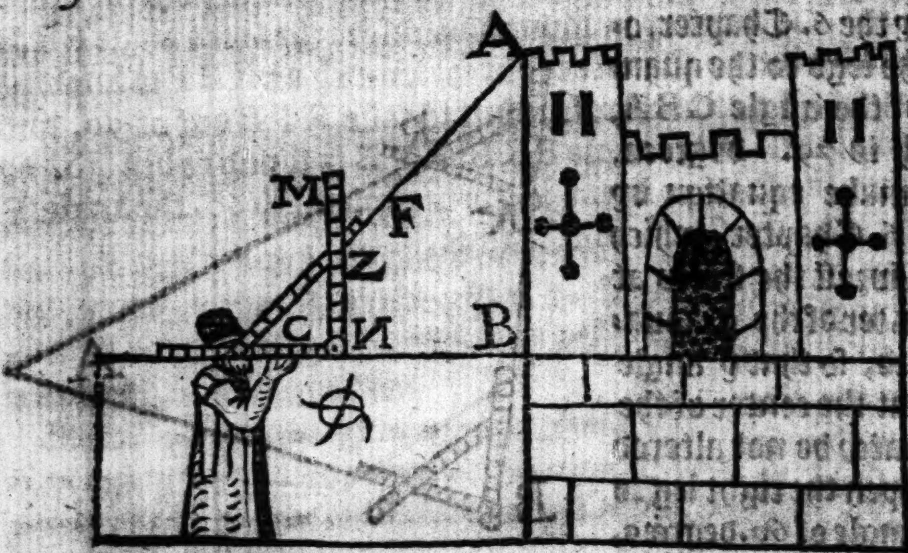
So haue you the third angle, and the two ſides of the unknowne Tryangle, knowne, which was required.

CHAP. XXX.

To take the height of any acceſſible thing, ſtanding perpendicular.

Altitude.

TAke by the 4. Chapter, 3. Propoſition, the angle of altitude, viz. A C B, then meaſure the line C B, which is 27.½ yards. Now you néede not to ſeeke yͤ angle C B A, becauſe he is knowne to be right, therefore you néede to doe no more but remoue the graduator 27.½ equall parts from the center, and there place him at a right angle, then the legges reſting at the angle A C B, the parts of the graduator cut by the right legge ſhewes the altitude, which will be 29. yards.



Or if you cannot place the graduator at a right angle, then make equation by the 26. Chapter: which done, wreſt the ſcrew at the center of the graduator hard, ſo remouing the right legge from the former angle unto a right angle, the parts then cut by the graduator upon the right legge is the foreſaid altitude, which will fall out to be 29. yards. And here you muſt note that you may not remoue the center of the graduator from the place hee was fixed firſt, as at 27.½.

If you underſtand this Chapter, the working of the 17. Chapter after this maner cannot be hid, onely the angle A C B is taken as an angle of longitude, ſee therefore the 4. Chapter, Prop. 1.

Chap. XXXI.

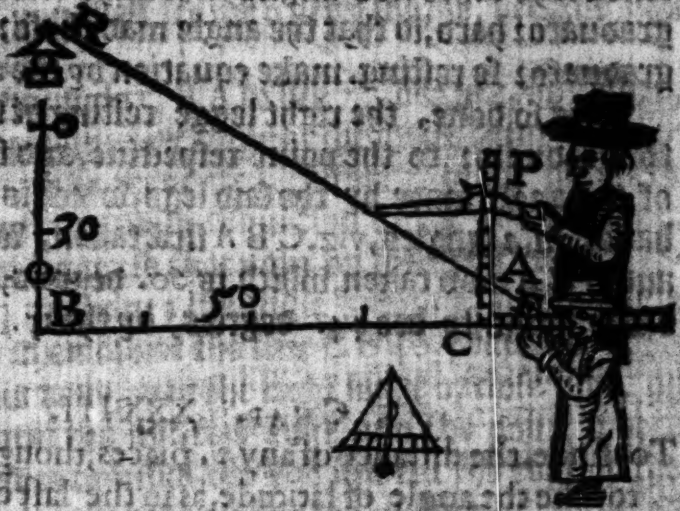
The height of a Tower, &c. giuen to fetch his diſtance from you, and the length of a ſcaling ladder, without meaſuring to the baſe.

The Propoſition.

Two angles of a Tryangle beeing knowne, whereof the one is ſcituate at the end of a line knowne, and the other oppoſite to the ſaid line knowne, to finde the third angle, and other two lines vnknowne.

Longitude.

Suppoſe I were ſtanding at F, and that I were deſirous to know the diſtance of F B and F R: firſt I take the angle of altitude by the 4. Chapter, Prop. 3. viz. R F B, and now the other angle R B F is already knowne: wherefore the third angle F R B is found by the 30. Chapter: but foraſmuch as R B F is knowne to be right, I neede therefore but to take R F B out of 90. and the remainder is the angle F R B: R F B is found to bee 30. or thereabouts; take 30. from 90. there remaineth 60. the angle F R B, then for the ſides, worke thus.



Open ẏ legs to the angle F R B, viz. 60. then remoue the cẽter of the graduator ſo farre from the center of the legs as ẏ line B R inſtructs you, that is 30. yards, hee reſting there, make equatiõ by the 26. Chapter, not ſtirring the right legge: which done, faſten the graduator at that angle: laſtly remoue the right leg vnto a right angle, ſo is the parts of ẏ right leg cut by the Graduator the length of B F, viz. 50. yards: and the equall parts of the graduator which are included betwixt ẏ two legges, the length of F R, the hipothenuſall or ſcaling ladder.

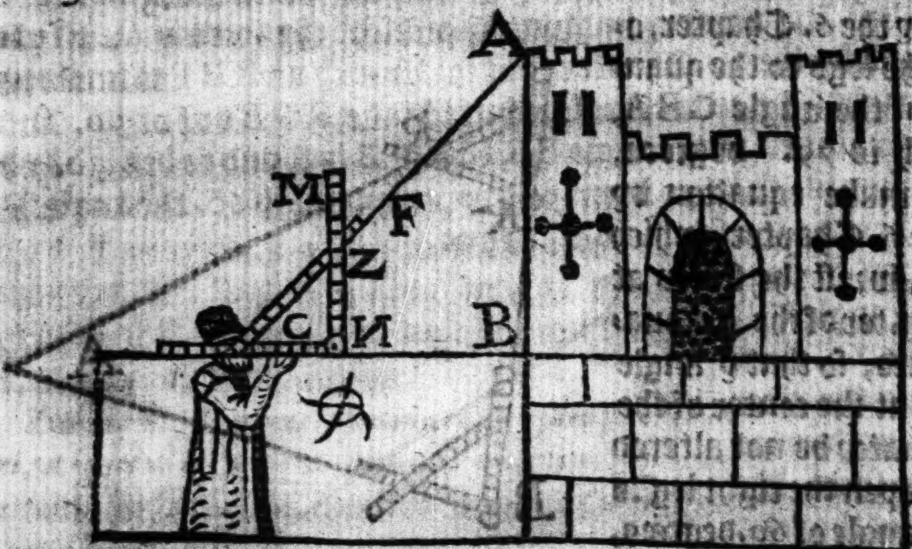
And ſo might you haue fetcht the length of R B ſtanding at B, by knowing the line B F.

CHAP. XXX.

To take the height of any acceſſible thing, ſtanding perpendicular.

Altitude.

TAke by the 4. Chapter, 3 Propoſition, the angle of altitude, viz. A C B, then meaſure the line C B, which is 27.½ yards. Now you neede not to ſeeke yͤ angle C B A, becauſe he is knowne to be right, therefore you neede to doe no more but remoue the graduator 27.½ equall parts from the center, and there place him at a right angle, then the legges reſting at the angle A C B, the parts of the graduator cut by the right legge ſhewes the altitude, which will be 29. yards.



Or if you cannot place the graduator at a right angle, then make equation by the 26. Chapter: which done, wreſt the ſcrew at the center of the graduator hard, ſo remouing the right legge from the former angle unto a right angle, the parts then cut by the graduator upon the right legge is the foreſaid altitude, which will fall out to be 29. yards. And here you muſt note that you may not remoue the center of the graduator from the place hee was fixed firſt, as at 27.½.

If you underſtand this Chapter, the working of the 17. Chapter after this maner cannot be hid, onely the angle A C B is taken as an angle of longitude, ſee therefore the 4. Chapter, Prop. 1.

CHAP.

Chap. XXXI.

The height of a Tower, &c. giuen to fetch his diſtance from you, and the length of a ſcaling ladder, without meaſuring to the baſe.

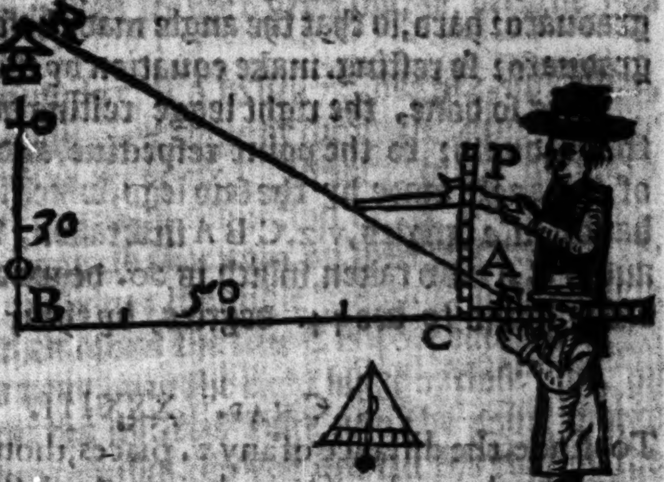
The Propoſition.

Two angles of a Tryangle beeing knowne, whereof the one is ſcituate at the end of a line knowne, and the other oppoſite to the ſaid line knowne, to finde the third angle, and other two lines vnknowne.

Longitude.

Suppoſe I were ſtanding at F, and that I were deſirous to know the diſtance of F B and F R: firſt I take the angle of altitude by the 4. Chapter, Prop. 1. viz. R F B, and now the other angle R B F is already knowne: wherefore the third angle F R B is found by the 30. Chapter: but foraſmuch as R B F is knowne to be right, I neede therefore but to take R F B out of 90. and the remainder is the angle F R B: R F B is found to bee 30. or thereabouts, take 30. from 90. there remaineth 60. the angle F R B, then for the ſides, worke thus.

Open ẏ legs to the angle F R B, viz. 60. then remoue the center of the graduator ſo farre from the center of the legs as ẏ line B R inſtructs you, that is 30. yards, hee reſting there, make equatiõ by the 26. Chapter, not ſtirring the right legge: which done, faſten the graduator at that angle: laſtly remoue the right leg vnto a right angle, ſo is the parts of ẏ right leg cut by the Graduator the length of B F, viz. 50. yards: and the equall parts of the graduator which are included betwixt ẏ two legges, the length of F R, the hipothenuſall or ſcaling ladder.



And ſo might you haue fetcht the length of R B ſtanding at B, by knowing the line B F.

Chap. XXXII.

Two ſhips ſeene vpon the ſeas, or two Towres vpon the land, to fetch the diſtance betwixt them both.

The Propoſition.

An angle knowne, and two lines knowne, containing the ſaid knowne angle, to finde the other two angles vnknowne, and the third line.

Latitude.

Let C A be two markes, whoſe diſtance is required, firſt by the 30. Chapter take the diſtance of B C, and you ſhall finde it 40. pearches, then by the ſame Chapter, take the diſtance of B A, which you ſhall finde 49. pearches, then take the angle C B A by the 2. Prop. Chap. 4. this done, ſtay the legges at that angle, and count the length of C B vpon the left leg, thereto bring the center of the graduator, then count the line B A vpon yͤ right legge, and thereto bring the edge of the graduator: the equall parts then vpon the graduator included betwixt both the legs, is the diſtance of C A, viz, 55. pearches. Now to find the quantitie of the other two angles, wreſt the ſcrew at the center of yͤ graduator hard, ſo that the angle made before be not altered; the graduator ſo reſting, make equation by the end of the 26. Chap. This ſo done, the right legge reſting at that angle, remoue the graduator to the point reſpectiue, and ſo find the quantitie of the angle made by the ſaid legs, which is 60. degrées: ſo now haue you 2. angles, viz. C B A firſt taken, which is 79. degrées, and B C A now taken, which is 60. degrées; ſo is the third angle eaſily found to bee 44. degrées, by the 15. or 30. Chapter.

Chap. XXXIII.

To finde the diſtance of any 2. places, though you cannot come to take the angle of latitude, as in the laſt chapter.

The Propoſition.

Two lines and one angle being giuen, ſo that the one line is the ſide of the angle knowne, and the other doth ſubtend the ſaid angle, yet to finde the third line, and the other two angles vnknowne.

Suppoſe you knew how farre B were off C, and alſo how farre C were off A: but you deſired to know how farre A were off B, now ſuppoſe you durſt not go to C to take the angle of latitude, but were compelled to ſtand at B.

Firſt therefore take the angle C B A, the féete reſting at that angle 79.degrées, remoue the center of the graduator vpon the left leg to the length of B C, viz. 40. pearches, this done, count the line C A vpon the graduator, viz. 55. ſtirring the moueable end of the graduator, vntill the number of 55. agrée iuſt with the fiduciall edge of the right legge: the parts then cut by yͤ graduator vpon the ſaid right legge, is the true length of A B, 49. pearches.

Now to finde the other two angles, the center of the graduator faſtned at his former angle, by the end of the 26. Chapter, make Equation, not ſtirring the graduator, which done, bring the graduator to the point reſpectiue, and ſo by the 5. Chapter, finde the quantitie of the angle made at the center of the legges, which you ſhall finde to be 60. ſo haue you two angles, A B C, 79.degrées, and B C A 60: then by the 15.or 30.Chapter, the other is found eaſie to be 44.degrées,* or otherwiſe, as is ſaid.

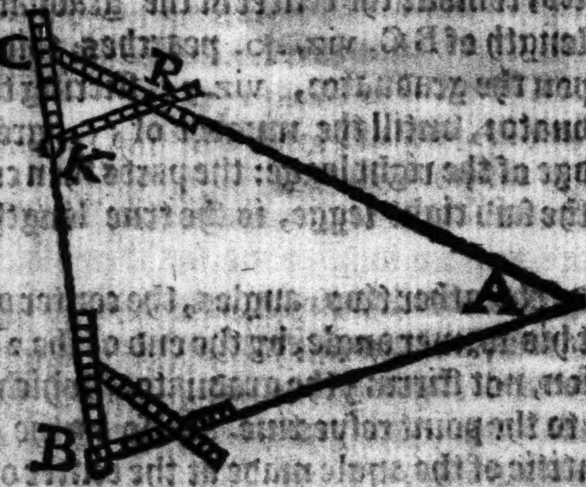
Lib.6.chap.13.

I haue worked in this Chapter ſomething from the nature of the Prop. though nothing from the truth: for the words of the propoſition be, that the one of the ſides ſhould ſubtend the angle knowne, which you ſhall ſee me briefly worke, becauſe you may ſée the diuerſities.

Hauing taken the angle C B A to bee 79.degrées, as before, count the ſide C A vpon the left legge of the inſtrument, where to bring the center of the graduator, (hitherunto the worke is all one.) Now muſt you make Equation by the 26. Chapter, not ſtirring the right legge: ſo that now by tranſpoſition, the center of the graduator containes the angle knowne, which angle muſt be kept truely; then count the line C B 40. pearches vpon the right legge, this done, open the right legge or cloſe him, as occaſion ſerueth, vntill the fiduciall edge and the point where the 40. pearches before counted, did end, iuſt cut the edge of the graduator: the equall parts then vpon the graduator, included betwixt the two legs, is the length of the line B A, 49.pearches, as before.

Now to finde the two vnknowne angles, you muſt meaſure the quantitie of the angle which is made at the center of the legs by the 5. Chapter,* which you ſhall finde to be 60. degrées, ſo haue you the firſt angle 79.degrees, this 60.degrées; the third therefore cannot be vnknowne, as before.

*Vide.lib.6.
chap.13.



Chap. XXXIIII.

Any Tower or ſuch like ſeene before you, to fetch the altitude & hipothenuſall diſtance thereof at two ſtations.

Conditio regulæ animaduertẽda.

IN this kinde of dimenſion, I am to forewarne you of one thing, which ought to be obſerued in all propoſitions before, where the angle of altitude is twice taken; that is, that the leg of the inſtrument which lyeth parallell, be placed direct in ẏ ſame line of leuell at the ſecond ſtation, as he was at the firſt, ſo that it is not lawfull at the firſt ſtation to plant the inſtrument high, and at the ſecond lowe, although at both ſtations you haue reſpect to the parallitie of the legge; therefore looke what part of the altitude is leuell with your eie at the firſt ſtation, & that make againe leuell with your eie at the ſecond ſtation: ordering your ſtaffe thus, you may procede without the producement of any errour at all.

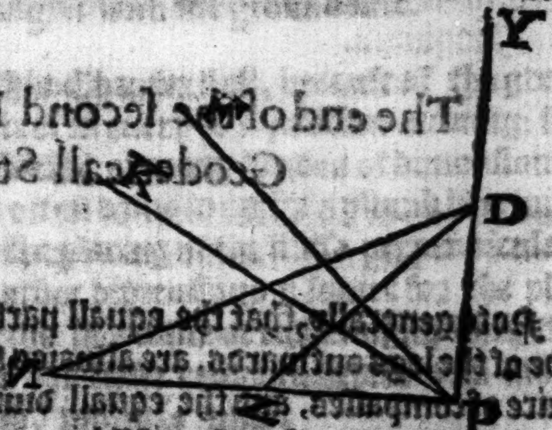
Altitudo.

Let the Propoſition be to fetch the altitude of A C: firſt I take the angle of altitude A K C, which I finde 45. degrees; next I take (going backwards ſome reaſonable diſtance) I take the angle of altitude A D C, 23. degrées: then I meaſure the diſtãce of K D, which is 6. pearches: theſe thrée had, I note them downe, and procéede thus.

**Lib.6.Cap.13.*

Open the legge by * the 6. Chapter to 45. degrées, the angle taken at my firſt ſtation K: then make equation by the 26. chap. but firſt draw the center of the graduator to ſome point in the left legge, as to Z in the enſuing figure, ſo by tranſpoſition is ẏ angle at the center of the graduator D Z P, equall vnto the angle at the center of the inſtrument F P Z: the graduator ſo reſting, remoue the right legge vnto a right angle, then diligently obſerue where the fiduciall edge of the graduator cutteth the right legge, which will fall out at the point D; this done, make a note where the center of the graduator was, as at Z; then by the 6. Chapter* open the legges vnto the angle made at the ſecōd ſtation D, 23. degrées; which done, make equation, the wreſt the ſcrew hard, that the angle at the center of the graduator bée not altered: now remoue the right legge vnto a right angle, and draw backe the center of the graduator, vntill the fiduciall edge thereof fall againe vpon the point D before noted in the right legge Y P: then note the parts included betwixt D P on the right legge, and N Z vpon the left legge.

* Lib. 6. chap. 13.



The legs with the Geometricall ground of the worke.

Now thus may you inferre the proportionall termes, as D P is to N P, ſo is C D in the 22. Chapter to A C: but you ſee part of C D is vnknowne, therefore argue it thus from the parts knowne, ſaying, as N Z, the parts included vpon the left legge N P, is to D P the ſigment of the right legge, ſo is D K in the 22. Chapter, the diſtance betwixt the two ſtations, to C A the altitude: N Z containes 144. parts, and D P 144. parts alſo; the diſtance betwixt the 2. ſtations is 6. pearches: therefore worke by the 29. Chap. and you ſhall find the altitude A C to be 6. pearches, equall wͭ the length of the two ſtations, and ſo of any other, length or depth, thus farre the ſector.

The Geometricall ground.

Si Triangula ſunt æquiangula ſeu ſimilia, cruribus homologis proportionalia, & contra.

Eu 4.5.6.& 7. Prop.6.

The Tryangle A C D and D P N are alike, and the angle A C D and D P N are equall, therefore D P is alſo parallell to A C, as may be proued*: therefore by the ſame reaſon ¶, ẏ thighs of both the Tryangles bee proportionall among themſelues, ſo

*Eu.31. P.1. Ra.5.conſi.3.pro.12.

¶ Eu.2. Pro.6. & 17.p.11.

that as A C is to C D, ſo is D P to P N: and as N P is to N D, ſo is C D to A C: in like maner as N P is to P D, ſo is D C to C A, and as N P is to D C, ſo is P D to C A.

Fundamentum eſt. 4. 5. 6. 7. 8. 9. 10. 11. & 12. p. 6. R. lib. 5. P. 13. lib. 6. p. 8.

And againe for our purpoſe, as N Z is to P D, ſo is D K to C A, as before; or as N Z is to D K, ſo is P D to C A.

As the firſt of theſe two laſt demonſtrations ſerue for this laſt Chapter, ſo alſo doth it hold in the 22. Chapter, and therefore may the ſaid 22. Chapter be wrought by the 29. Chapter.

The end of the ſecond Booke of the Geodeticall Staffe.

Note generally, that the equall parts inſerted vpon the vpper ſide of the legs outwards, are alwaies to worke by yͤ helpe of a paire of compaſſes, and the equall diuiſions inwards to worke by the graduator: therefore if I bid you ſee what number of equall parts the graduator cuts, you muſt ſeeke it amongſt the equall parts vpon the inward ſide of the legs.

THE

THE THIRD BOOKE OF the Geodeticall Staffe, concerning the vſe of the Hypſometricall Scale.

CHAP. I.

To place your ſtaffe vpon plaine ground, ſo that he may ſtand iuſt perpendicular on the line of leuell, or vpon ſlopy or hilly ground to make right angles with the ground line.

I Place this Chapter firſt, becauſe of the great vſe thereof in euery Propoſition enſuing; for in the taking of many kindes of dimenſions, I was often driue to carrie a plumb line with me for the placing of the ſtaffe perpendicular, and in other dimenſions, a ſquier for the placing of the ſaid ſtaffe at right angles with the ground line, vntill at laſt the ſtaffe yéelded a better and more eaſie way vnto me himſelfe, which is thus.

To place the ſtaffe at right angles with the ground line.

From the place where you will plant your ſtaffe towards the marke, whoſe diſtance is deſired, meaſure ẏ iuſt length of your ſtaffe, and there make an apparent marke: your ſtaffe then being placed in the extremes of the laſt meaſured line, and in the end furtheſt diſtant from the marke whoſe diſtance is required, open the legges vnto an angle of 45. degrees, by the 6. Chapter, lib. 2. then bring the fiduciall edge of the left legge to agrée with the edge of the hollow ſtaffe beeing there fixed: and the angle before made not altered, moue the top of the ſtaffe towards or from-wards the marke, vntill by the fiduciall edge of the right legge you ſee the marke before noted vpon the ground to agrée there-with, ſo is the ſtaffe ready planted.

Chap. II.

To meaſure the diſtance of any marke ſeene before you in a right line.

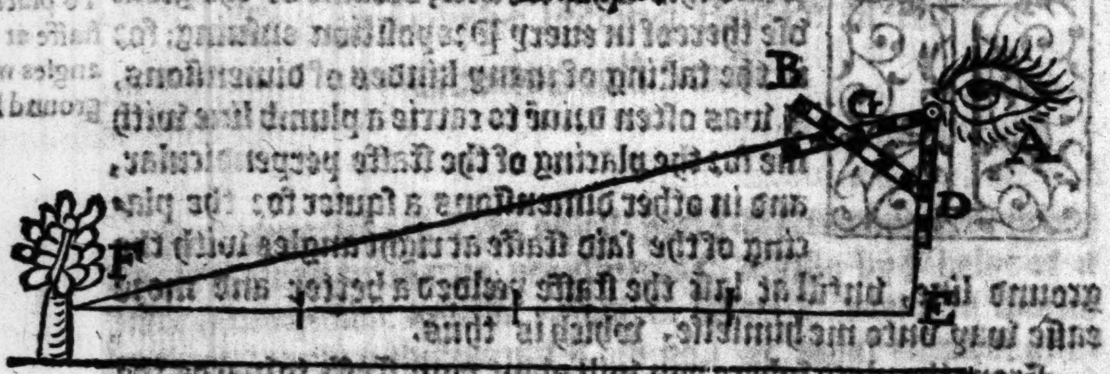
Orontius. Chap.4.

Qualiter linea recta in plano metiatur.

Take the legges out of the ſtaffe, and place them upon the ſide of the ſtaffe, placing the hollow ſtaffe ſo, that hee may not leane towards or fromwards the marke whoſe diſtance is required, as in the laſt Chapter: then by the 4. Chapter, Prop. 1. Booke 2. take the angle of longitude, and wreſt the ſcrew pin hard, ſo that the angle be not altered: next bring the center of the graduator unto the left point reſpectiue, and then turne the parts of the ſcale towards the legge*, and note what parts are there cut by the right point reſpectiue; for ſuch proportion as ẏ parts cutte haue to 12. the ſame hath the hollow ſtaffe to the length required.

Lib.1.Pro.2. Defi.10.

Example.



Let G the point reſpectiue cut D B the graduator at 3. parts, and for becauſe 3. is to 12. in a Quadruplate proportion, I conclude E F the line required, to containe the length of the ſtaffe 4. times, whereupon the ſtaffe being foure foote, I may inferre the line to be 16. foote.

**Lib.2.*

Hopt. Or worke thus by the* 29. Chapter, ſaying, if 3. giue 12. what ſhall 4. giue? and you ſhall finde 16. and here it were fit to vſe the fourth note of the firſt Chapter, Booke 2.

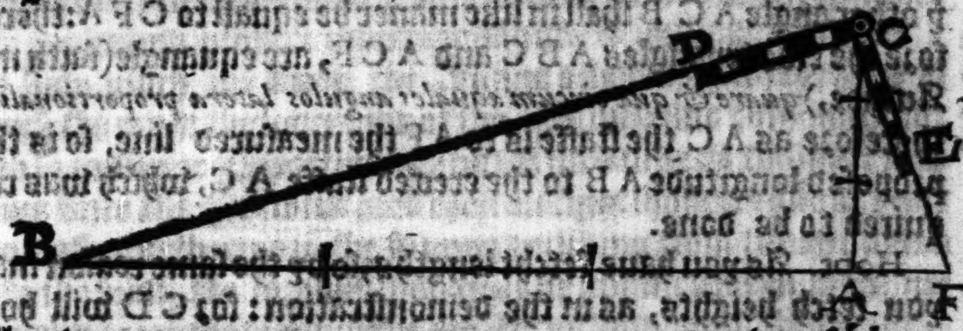
Chap. III.

To performe the former Propoſi. where a diſtance is required, by the onely helpe of a vulgar gnome, or Carpenters ſquire, repreſented on the ſtaffe.

Orontius Chap.5.

Via operandi vulgati Gnomonis.

It hath pleaſed ſome to adioine a maner of meaſuring without the hypſometricall ſcale, whereby the length of the foreſaid lines lying vpon plaine ground, are obtained as it were at an inſtant by a gnomon or right angled figure, ſuch as Mechanicks vulgarly vſe, called a ſquire. I would not let paſſe this kinde of meaſuring (ſaith my Author) aſwell for that it is facill and eaſie, as alſo becauſe it ſeldome happens that ſuch meaſures haue alwaies a ſcale at hand, let therefore the right line be giuen, whoſe longitude thou doſt deſire, and let it be A B: then by the firſt



Chapter erect your ſtaffe A C, then take the graduator of yͤ legs, and open them vnto a right angle, as D C E, then place the center C vpon the ſide of the ſtaffe, not altering the angle, lift vp or depreſſe downe both the legges vntill by the fiduciall edge of C D, the viſuall beame concurre iuſt with the further terme or end of the line whoſe length is ſought, as to B: the legges ſo reſting and the right angle not altered, wreſt the center pin hard, and there let the inſtrument remaine, then looke by the fiduciall edge of the other legge C E, and note where the viſuall beames touch the ground, as at F, which noted, ſay thus:

Such proportion as the erected ſtaffe A C hath to the parts A F, the ſame ſhall the line A B haue to A C, the length of the ſtaffe.

As if A C be 6. foote, and A F 2. foote, becauſe 6. to 2. hath a triple proportion, therefore the propoſed longitude A B ſhall three times containe ſix feete the length of the ſtaffe, which is 18. feete.

Hope. But my ſtaffe is but 4. feete, and A F falleth out to be 1. foote and foure inches, which is alſo in a triple proportion to 48. inches, which is foure foote: worke by the twenty eight Chapter, Booke 2.

The Geometicall demonſtration hereupon.

Deductio prædictorum geometrica.

In the Tryangle B C F, the 3. angles bee equall vnto a right angle, as may be proued*: but B C F is a right angle, therefore the other two, C B F, and B F C together are equall vnto a right angle: alſo by the ſame reaſon the two angles A C F, and C F A in the tryangle A C F, are together equall to one right angle: for

* Eu. lib. 1. pro. 32.

Chap. II.

To meaſure the diſtance of any marke ſeene before you in a right line.

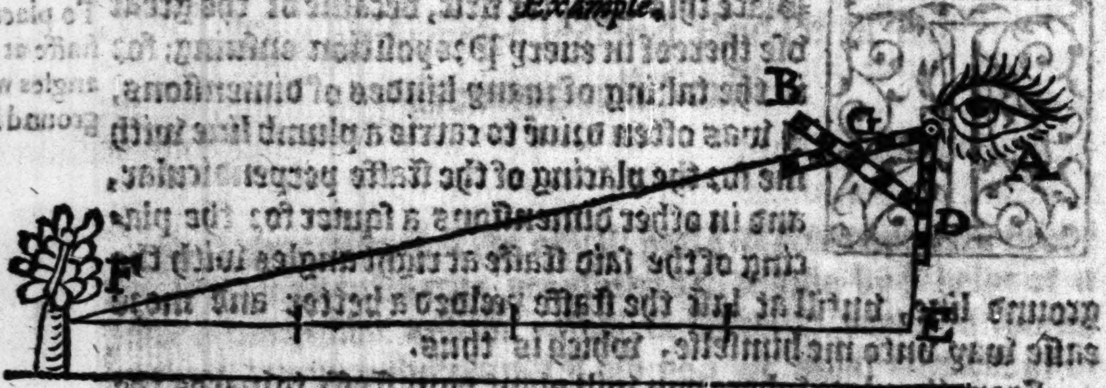
Orontius. Chap. 4.

Qualiter linea recta in plano metiatur.

Take the legges out of the ſtaffe, and place them vpon the ſide of the ſtaffe, placing the hollow ſtaffe ſo, that hee may not leane towards or fromwards the marke whoſe diſtance is required, as in the laſt Chapter: then by the 4. Chapter, Prop. 1. Booke 2. take the angle of longitude, and wreſt the ſcrew pin hard, ſo that the angle be not altered: next bring the center of the graduator vnto the left point reſpectiue, and then turne the parts of the ſtale towards the legge*, and note what parts are there cut by the right point reſpectiue: for ſuch proportion as yͤ parts cutte haue to 12. the ſame hath the hollow ſtaffe to the length required.

Lib. 1. Pro. 2. Defi. 10.

Example.



Let G the point reſpectiue cut D B the graduator at 3. parts, and for becauſe 3. is to 12. in a Quadruplate proportion, I conclude E F the line required, to containe the length of the ſtaffe 4. times, whereupon the ſtaffe being foure foote, I may inferre the line to be 16. foote.

Hopt. Or worke thus by the* 29. Chapter, ſaying, if 3. giue 12. what ſhall 4. giue? and you ſhall finde 16. and here it were fit to vſe the fourth note of the firſt Chapter, Booke 2.

*Lib. 2.

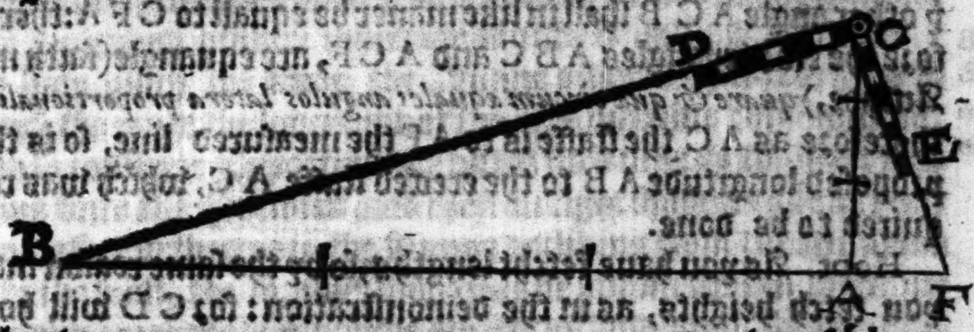
Chap. III.

To performe the former Propoſi. where a diſtance is required, by the onely helpe of a vulgar gnome, or Carpenters ſquire, repreſented on the ſtaffe.

Orontius Chap. 5.

Via operandi vulgati Gnomonis.

It hath pleaſed ſome to adioine a maner of meaſuring without the hypſometricall ſcale, whereby the length of the foreſaid lines lying vpon plaine ground, are obtained as it were at an inſtant by a gnomon or right angled figure, ſuch as Mechanicks vulgarly vſe, called a ſquire. I would not let paſſe this kinde of meaſuring (ſaith my Author) aſwell for that it is facill and eaſie, as alſo becauſe it ſeldome happens that ſuch meaſures haue alwaies a ſcale at hand, let therefore the right line be giuen whoſe longitude thou doſt deſire, and let it be A B: then by the firſt



Chapter erect your ſtaffe A C, then take the graduator of yͤ legs, and open them vnto a right angle, as D C E, then place the center C vpon the ſide of the ſtaffe, not altering the angle, lift vp or depreſſe downe both the legges vntill by the fiduciall edge of C D, the viſuall beame concurre iuſt with the further terme or end of the line whoſe length is ſought, as to B: the legges ſo reſting and the right angle not altered, wreſt the center pin hard, and there let the inſtrument remaine, then looke by the fiduciall edge of the other legge C E, and note where the viſuall beames touch the ground, as at F, which noted, ſay thus:

Such proportion as the erected ſtaffe A C hath to the parts A F, the ſame ſhall the line A B haue to A C, the length of the ſtaffe.

As if A C be 6. foote, and A F 2. foote, becauſe 6. to 2. hath a triple proportion, therefore the propoſed longitude A B ſhall three times containe ſix feete the length of the ſtaffe, which is 18. feete.

Hope. But my ſtaffe is but 4. feete, and A F falleth out to be 1. foote and foure inches, which is alſo in a triple proportion to 48. inches, which is foure foote: worke by the twenty eight Chapter, Booke 2.

The Geometicall demonſtration hereupon.

Deductio prædictorum geometrica.

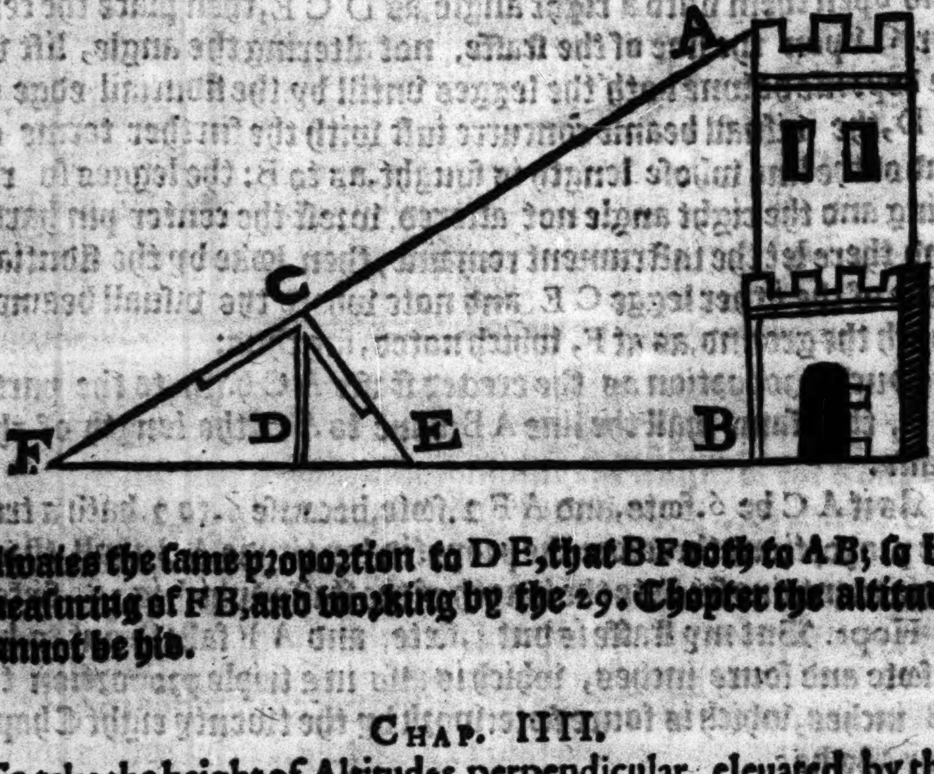
In the Tryangle B C F, the 3. angles bee equall vnto a right angle, as may be proued*: but B C F is a right angle, therefore the other two, C B F, and B F C together are equall vnto a right angle: alſo by the ſame reaſon the two angles A C F, and C F A in the tryangle A C F, are together equall to one right angle: for the

* Eu. lib, 1, pro, 32.

the third C A F is right, therefore the two angles C B F and B F C, are in like maner equall to the two right angles A C F and C F A, becauſe they be coequated by a like angle, that is to ſay, with a right angle: but if you doe take the angle B F C, common to both, from thoſe equall angles, the remainder C B A by common ſentence will be equall to the other A C F, and the angle B C A is equall to the angle C A F: for they be both right, and therefore yͤ other angle A C B ſhall in like maner be equall to C F A: therefore the two tryangles A B C and A C F, are equangle (ſaith my Author,) *quare & quæ circum æquales angulos latera proportionalia:* therefore as A C the ſtaffe is to A F the meaſured line, ſo is the propoſed longitude A B to the erected ſtaffe A C, which was required to be done.

**Orontius. 4. Eu. lib. 6.*

Hopt. As you haue fetcht lengths, ſo by the ſame reaſon may you fetch heights, as in the demonſtration: for C D will hold alwaies the ſame proportion to D E, that B F doth to A B; ſo by meaſuring of F B, and working by the 29. Chapter the altitude cannot be hid.



Chap. IIII.

To take the height of Altitudes perpendicular, eleuated by the meanes of ſhadowes, with the Geodeticall ſtaffe.

Orontius Chap. 8.

Although (ſaith Orontius) we haue determined to ſet downe the difference of ſhadowes to the thing enſuing ſhadowe, in their place, that is in our fourth Booke of Coſmography, howbeit we ſhall not bring it out of ſeaſon, hereto deliuer a preguſtation in briefe, how things directed Orthogonaliter vpon the plaine of the earth, doe ſéeme to exceede their altitudes. Therfore of ſhadowes we muſt vnderſtand which be called right, that is to ſay, which are extended in length and direct on the plaine of the earth, and doe make right angles with the thing cauſing ſhadowe; ſuch are the ſhadowes of Turrets or any other thing perpendicular, eleuated vpon plaine ground: but all right ſhadows are protended infinite when the Sunne is in the eaſt or weſt, & by how much the more the Sunne aſcends vpwards, by ſo much the more the longitude of the ſaid ſhadowe doth decreaſe, and ſo continue proportionally vntill ſuch time as the Sun ſhall come vnto the Meridian, and then all right ſhadowes be at their ſhorteſt. Furthermore, the Sunne declining from the Meridian into the weſt, the foreſaid ſhadowes be augmented in right order, and are made ſo much the greater by how much the more the Sunne ſhall be nearer vnto ſetting: but on this condition, that the Sunne béeing in points diſtant alike from the Meridian, the longitude of the ſhadowe ſhall fall out alike.

Vmbrarũ rectarum Definitio.

De vmbrarum rectarum cremento atque decremento.

1 Now to fetch the altitude of any thing by the ſhadow thereof, firſt by the 4. Chapter, Prop. 3. Booke 2. take the height of the Sunne, and faſten the legs at that angle; then bring the gradator vnto the point reſpectiue in the left legge, and note the parts of the ſcale cut by the right point reſpectiue*: if it fall out in the contrarie ſhadow, you may ſafely conclude the length of yͤ ſhadowe to be longer then the altitude ſought; and the ſame proportion as 12. hath to the parts cut, the like hath the length of the ſhadowe to the height required.

Operandi modus quando vmbra maior eſt vmbroſi longitudine per Bac. Geod.

** Lib. 1. Pro. 2. Deſi. 10.*

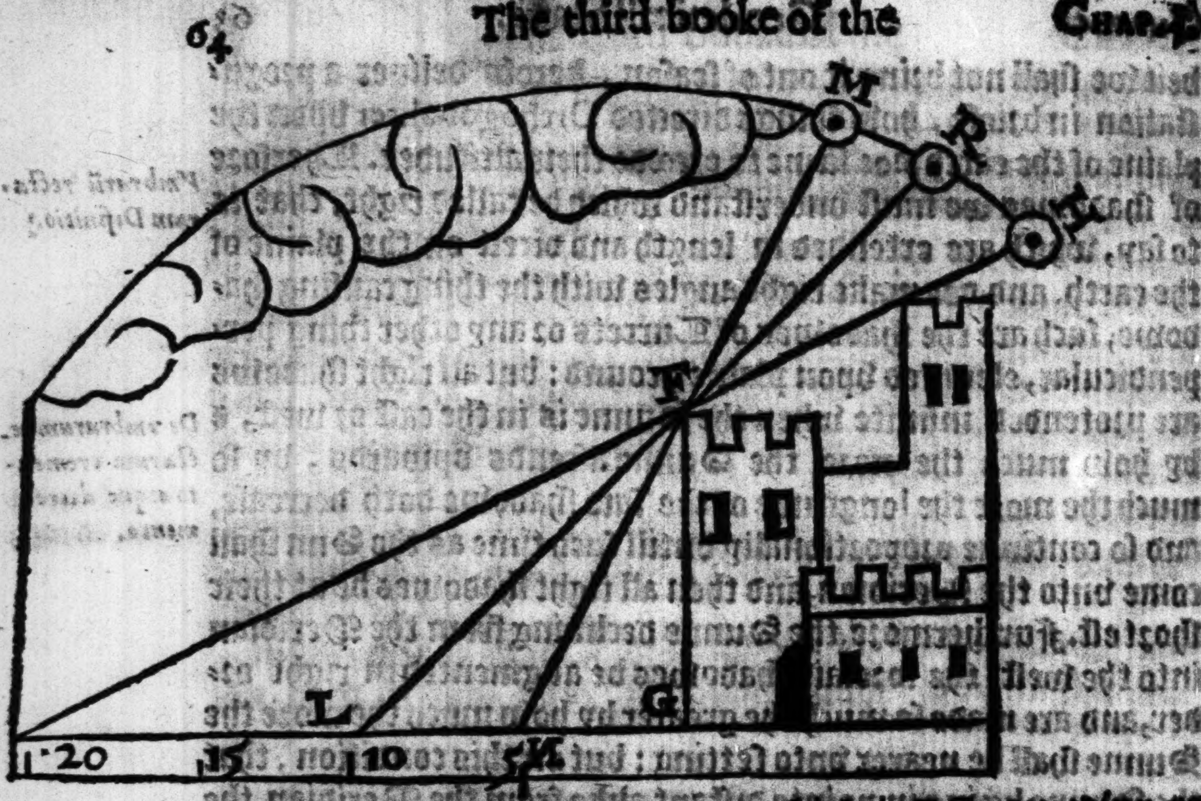
Example.

Wée will take Orontius his example, let 6. bee the parts cut on the gradator by the right point reſpectiue, & let the altitude cauſing ſhadow be F G, and the ſhadow it yeeldeth G I, yͤ beames of the Sun H I: now becauſe 12. is to 6. in a duplatiue proportion, I conclude, the altitude F G to be twice contained in G I the ſhadowe; therefore becauſe I G is 20. paces, G F of conſequence muſt néeds be 10. paces.

Or multiply the length of G I by the parts cut, and make diuiſion by 12. ſo haue you the altitude, as may bee proued by the demonſtration of Orontius in this Chapter.

Example.

Multiply 20. by 6. there riſeth 120. which diuide by 12. & there comes



comes 10. ſo many pearches or paces high is F G, according as you did meaſure G I by pearches or pearches.

Hopt. But with more eaſe then any of theſe, worke by the 29. Chapter, Booke 2, thus: if 12. giue 6, what ſhall 20. giue? ſo ſhall the graduator cut 10, as before.

Dum vmbra ſuo æquatur vmbroſo.

2 If you take the altitude of the Sun, as before, and the right point reſpectiue, cut 12. parts iuſt, then the altitude is equall unto the length of the ſhadowe, therefore meaſure the ſhadowe, & the deſired altitude cannot be hid.

Example.

Let F G be the altitude required, the Sun being in K, whoſe beames A K L, and the ſhadowe G L, which ſhall bee equall to G F.

De vmbra altitudine vel vmbroſo minore.

3 If you take the altitude of the Sunne by the 1. Booke, Chap. 4. Prop. 3. as before, bringing the graduator unto the points reſpectiue, and ſee the parts cut to be in the right ſhadow or parts next to the moueable end of the graduator, then is the ſhadowe of the bodie cauſing ſhadowe ſhorter then the bodie it ſelfe.

Therefore ſuch proportion as the parts cut haue to 12. the ſame hath the length of the ſhadowe to the height.

Example.

Let the right point reſpectiue cut the graduator in 6. parts of the right ſhadowe, let the ſhadowe be G N, the Sunne beames M N, M N, let the length of the ſhadowe G N be 5. paces: then for as much as 6. is to 12. in a ſubduplatiue proportion, therefore G N is halfe the height of G F: which doubled, maketh the iuſt altitude, viz. 10. paces.

Generally multiply the length of the ſhadowe by 12. and diuide by the parts cut: the quotient is the altitude.

Example.

Multiply 5. by 12. there riſeth 60. which diuide by 6. the parts cut, there remaines 10. and ſo many paces high I conclude the altitude S G as before, and ſo for all the parts of the right ſhadowe.

Note. But without Arithmeticke, ſpeake as before, ſaying: if 6. giue 12. what ſhall 5.? and in ſo doing by the foreſaid doctrine, the graduator will cut 10. the height, as before. *Lib. 2. cap. 39.

And take this generall in all your obſeruations, if the altitude of the Sunne be vnder 45. degrées, then is the length of the ſhadowe greater then the bodie cauſing ſhadowe, and the point reſpectiue ſhall cut the graduator in the contrary ſhadow: which in our latitude falleth out from the 24. of Auguſt to the beginning of Aprill, becauſe in all that time the Sunne, commeth not at the neareſt within 45. degrées of our Zenith.

But if the altitude fall out to be aboue 45. degrées, then is the ſhadow ſhorter then the perpendicular body cauſing ſhadowe: & the parts cut by the point reſpectiue on the graduator, ſhall be in the right ſhadow, which falleth out in the Sommer time, from the beginning of Aprill vntill the 24. of Auguſt, becauſe the Sunne at that time towards the middeſt of the day moues nearer vnto the Zenith then to the Horizon, becauſe his meridian altitude is greater then the equinoctials height: which happen to regions on the north ſide the equinoctiall, when the Sunne is included betwixt the equinoctiall and the vernall Solſtitiall parallell or tropicke of Cancer, and with vs in England being 7. degrées north from the equator: and further, at halfe an howre after three of the clocke after noone, or ſo much after 8. in the forenoone, you ſhall neuer finde the point reſpectiue to cut in the right ſhadowe, (eſpecially towards the middeſt of England) tho you make obſeruation euen on the ſolſtitiall day: ſo that after 3. a clocke in the after noone, and after 8. before noone you ſhall neuer vſe the parts of the right ſhadow for the cauſe aboueſaid: but theſe differences I will reſerue vnto a larger volume, where it ſhall bee handled more artificially, onely here I giue a taſte thereof for the better vnderſtanding of the Staffe.

Note.

And you ſhall note that the firſt ſide of this ſcale, whereof the one is called Vmbra recta, the other Vmbra verſa, be no other th the Tangents of a leſſer marke in a ſemiquadrant, as you may perceiue in the appendix of the 7. Booke.

Chap. V.

To performe the laſt chapter with more eaſe.

Tabula vmbrarum.

1 Hauing taken the angle of altitude, note the part cut in the right or contrarie ſhadow, as before you did in the laſt Chapter: if the parts cut be in the right ſhadow, then reſort vnto the two rowes of figures placed vpon the backe ſide of the right legge neere the moueable end, and in the rowe vpon the left hand, finde the parts cut, anſwering to which is the figures ſet to expreſſe how often the length of the ſhadow muſt bee taken to finde the length of the thing cauſing ſhadowe, as in the Table in the margent appeares, which Table muſt bee placed vpon the right legge, as hee is here.

1	12
2	6
3	4
4	3
5	$2\frac{2}{5}$
6	2
7	$1\frac{5}{7}$
8	$1\frac{1}{2}$
9	$1\frac{1}{3}$
10	$1\frac{1}{5}$
11	$1\frac{1}{11}$
12	1

Example.

I finde, hauing taken the Sunnes angle of altitude, that the point reſpectiue cuts 4. parts of the right ſhadowe, which 4. I finde in the rowe vpon ye left hand, anſwering to which is 3. placed, ſignifying vnto you, that you muſt take the length of the ſhadowe 3. times to make the altitude cauſing the ſhadowe.

2 If the point reſpectiue cut the graduator in the contrarie ſhadowe, reſort alſo vnto the ſaid Table as before, & the parts anſwering to the parts cut, ſheweth thee how often the height is contained in the ſhadow, that is, how often the length of the ſhadowe doth containe the height of the thing cauſing ſhadowe.

Example.

Hauing taken the angle of altitude as before, I find the point reſpectiue to cut 8. parts of the contrary ſhadowe, anſwering to which in the Table of ſhadowes is ſet $1\frac{1}{2}$, which ſhewes ye ſhadowe containes the altitude cauſing ſhadow, once and a halfe; therefore if the ſhadowe were 12. foote, the height was but 9. foote.

Chap. VII.

To finde the altitude of any body perpendicularly eleuated by the visuall beames, without the helpe of the Sunne.

Quentine: Chap: 9.

IT often falleth out when we would measure Altitudes after the foresaid maner, that by reason of the interposition of some darke cloud, the beames of the Sunne are made so weake, that there can no shadow happen: therefore wee must vſe the visuall beames of the eie thus.

Generalis operandi via.

Take the angle of altitude*, as before, then as you be accustomed bring the center of the graduator vnto the left point reſpectiue, and to the partacupt* by the right point reſpectiue, which done, proceede therein according to the 8. Chapter; for there it is performed in all reſpects, in which for the better opening of ẏ vſe of the ſtaffe, I will proceede more at large, taking the demonſtration in the ſaid 8. Chapter.

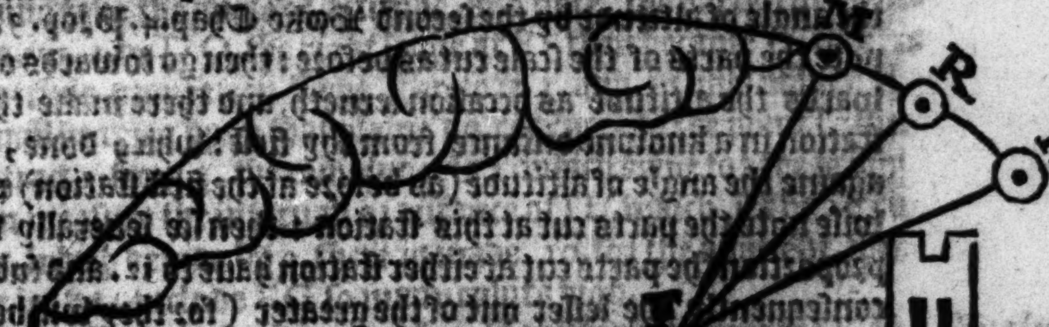
*Cap.4. Pro.3. lib.2.

*Pro.2. Def.10. lib.1.

1 Let the Towre proposed to be measured be F G, let the angle of altitude be F N G, and let the right legge cut the graduator at 6. parts of the right ſhadowe: therefore ſuch proportion as the parts cut haue to 12, the ſame hath the diſtance of N G to the altitude F G: N G is 5. paces, the parts cut be 6, therefore F G muſt needs be 10. paces.

Vide cap.4. apud

Quando altitudo propoſita maior eſt intercapedine plani.



De plani longitudine, propoſita altitudine æquali,

2 If the parts cut (when the angle of altitude is taken) be 12, then is the altitude equall with the length betwixt your ſtaffe & the baſe, adding (as you muſt before alſo) the diſtance of your eie from the ground thereunto: ſee the 4. Chap. at the figure 2.

Dum altitudo ab interuallo plani ſuperatur.

If the parts cut by the point reſpectiue fall in the contrarie ſhadow, then muſt you worke contrary vnto the operations in the right ſhadowe, after this maner: ſuch proportion as 12 hath to the parts cut, the ſame hath the length from your ſtaffe vnto the baſe to the deſired height, alwaies adding the height of your eie aboue the baſe thereunto. *Example.*

Let the parts cut be 6. in the contrary ſhadow, which is to 12 in ſubduple proportion: therefore the diſtance of your eie from the baſe, and this is twice ſo much as the altitude F G. G I is 20 parts, therefore G F is but 10. parts: worke therefore by Arithmeticke or without, as in the 8. Chapter at the figure 1. You ſhall alſo finde this Chapter to agree with the 9. Chapter, therefore the Table of ſhadowes ſet there may alſo be vſed heere in the ſame maner.

CHAP. VIII.

To ſearch out inacceſſible heights, with no leſſe eaſe then before.

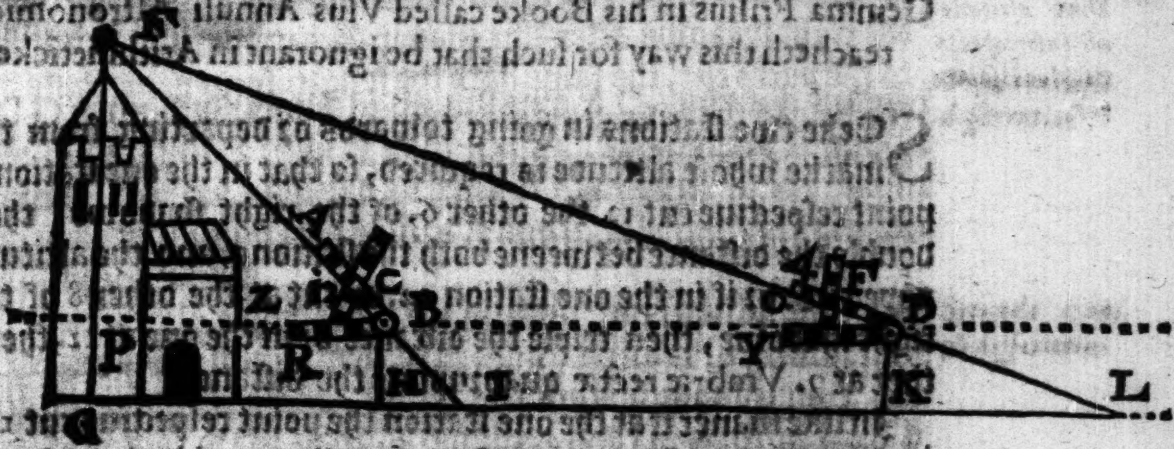
Canon generalis operationis.

IT often falleth out that you cannot haue acceſſe to the baſe of the perpendicular, whoſe altitude is required, and yet you are deſirous of ỹ height thereof, which you may eaſily performe thus.

Appoint thy firſt ſtation, and there place thy ſtaffe, and take the angle of altitude by the ſecond Booke, Chap. 4. Prop. 3. and note the parts of the ſcale cut as before: then go towards or frowards the altitude as occaſion ſerueth, and there make thy 2. ſtation in a knowne diſtance from thy firſt: which done, take againe the angle of altitude (as before at the firſt ſtation) & likewiſe note the parts cut at this ſtation: then ſee ſeuerally what proportion the parts cut at either ſtation haue to 12. and ſubtract conſequently the leſſer out of the greater (for they will bee alwaies vnequall) and the reſidue reſerue for the number of the altitude: then meaſure the diſtance betwixt the falling of the firſt viſuall beame and the ſecond, (or betwixt the two places where your ſtaffe was, if after you adde the diſtance of your eie from the baſe to the altitude) the occurrant or former number is to be deuided by this number of meaſures betwixt your two ſtations: the quotient ingendred by the diuiſion of this number, ſheweth the altitude, in thoſe parts or meaſures, as before you meaſured the diſtance of the two ſtations by.

Corolarium.

It ſometime happeneth that the diſtance intercepted betwéen both the ſtations is to be taken for the altitude, which comes to paſſe ſo often as after ſubtraction of the former numbers there remaineth but one, becauſe it is fruſtrate to deuide a number by one.



Let the altitude difficult to haue acceſſe vnto, be F G, and let your firſt ſtation be where you placed your ſtaffe, at the point H, and let the viſuall beames fall at I, and let the right legge B A cut twelue parts on the graduator at C; here the parts cut are equall to 12. therefore you ſhall keepe but one for the denominator in the firſt number.

Afterwards go backe to the ſecond ſtation, as at K, and there againe take the angle of altitude, and note the parts cut as before, viz. 4. by D O, the right legge at F: then becauſe 12. to 4. is in a triple proportion, kéepe therefore 3. and in like maner the viſuall beames vpon that plaine do concurre to the point L: then ſubtract 1. from 3. the remainder is 2. which kéepe for the height then meaſure the interuall or diſtance of I L, which let be 20. cubits, which deuide by 2. there is made 10. for the quotient, therefore let vs conclude F G ſo many cubits high.

Alius ad idem operandi modus.

Hopt. Here note, if you meaſure the diſtance betwixt H K, the places where your ſtaffe was, and omitte the reuerſed viſuall ſights D L and B I, then working as before, the altitude taken is ſo much of the Tower as was aboue the leuell of your eie at either ſtatiō, viz. Z: to which if you adde the length of your ſtaffe B H, or B K, the whole altitude from the baſe to the top appeares as before: and note further that the left legge D Y and B R muſt ly parallell, and at both ſtations point to one marke, as to Z, as is in the 36. Chapter, Booke, 2.

Chap. VIII.

To performe the laſt Propoſition with more eaſe, after Gemma Friſius.

Gemma Friſius. Chap. 8.

Gemma Friſius in his Booke called Vſus Annuli Aſtronomici, teacheth this way for ſuch that be ignorant in Arithmeticke.

Seeke two ſtations in going towards or departing from the marke whoſe altitude is required, ſo that in the one ſtation yͤ point reſpectiue cut 12. the other 6. of the right ſhadowe then double the diſtance betweene both the ſtations, and the altitude appeares: or if in the one ſtation 12. be cut at the other 8 of the right ſhadowe, then triple the diſtance, or in the one at 12, the other at 9. Vmbræ rectæ quadruplate the diſtance.

In like maner if at the one ſtation the point reſpectiue cut 12. in the other 8. of the contrary ſhadowe: then double the diſtance of both the ſtations, or one in 12. the other in 6. of the ſame ſhadowe; then the ſpace betwixt both the ſtations is equall to the height.

Alſo if the point reſpectiue cut 6. parts, vmbræ rectæ, and at the other ſtation 8. vmbræ verſæ, or 6. vmbræ verſæ, and foure of the ſame ſhadowe at the other ſtation, or 4. and 3. vmbræ verſæ, in all theſe the diſtance betwixt both the ſtations is equall to the height: remembring to adde the height of your eie aboue the baſe thereunto, as in the end of the laſt Chapter.

Chap. IX.

To take any perpendicular height by the onely helpe of the hollowe ſtaffe, without the aide of the legges.

Orontius Chap. 10.

Modus metiendi rerum altitudinis per Baculum Geodaticum abſque crurum beneficio.

Let your ſtaffe be deuided into 12 equall parts, then erect him orthogonaliter vpon the giuen plaine, ſo that hee lie parallell to the perpendicular altitude; then placing your eie at the ground, go backwards or forwards, as occaſion ſerueth, vntill ſuch time as thou doſt behold the ſummite or higheſt part of the thing to be meaſured by the head of the ſtaffe: which done meaſure the diſtance betwixt thy eie and the foote of the ſtaffe by the ſame parts of meaſure as the ſtaffe is deuided into: for ſuch proportion as the ſtaffe hath vnto the ſaid diſtance, the ſame hath yͤ propoſed altitude vnto the longitude intercepted betwixt thy eie and the baſe of the ſaid altitude.

1 Whereupon if the ſtaffe and the foreſaid diſtance be equall, ſo maiſt thou conclude the propoſed altitude to be ſo much as it is betwixt thy eie and the baſe thereof, as in the figure with this example is apparent.

Example.

Prima exempli differentia.

C D is the ſtaffe equall to the diſtance A C, included betwixt your eie A, and the foote of your ſtaffe C; whereupon it may be inferred, that the propoſed altitude B F is equall to the plaine A B included betwixt the points A and B, wherof both contain iuſt the ſtaues length.

Secunda exempli differentia.

2 But if it ſo happen that the foreſaid interuall be leſſe then the height of the ſtaffe, then the propoſed altitude is greater then the intercapedicall plaine, which is comprehended betwixt thy eie and the baſe of the altitude required; and the altitude hath yͤ ſame proportion vnto the longitude of the plaine, as the ſtaffe hath vnto the interuall, betwixt thy eie and the foote of the ſtaffe, as is not difficult to perceiue by the ſtaffe E G, and the interuall A E: for euen as the ſtaffe E G doth containe the interuall A E once and a halfe, after the ſame maner the altitude B H doth comprehend A B the longitude once and a halfe; A B the longitude doth containe 6. ſuch parts, therefore B H ſhall be 9. ſo that the halfe of A B is to be added the whole longitude, that the foreſaid altitude may appeare.

Tertia exempli differentia.

3 Furthermore if the foreſaid interuall be greater then the length of the ſaid ſtaffe, then the foreſaid longitude ſhall alſo be greater then the altitude propoſed, and in ſuch proportion the length ſhall exceede the height, as the interuall doth the ſtaffe.

Example.

As for the purpoſe, ſuch proportion as I K hath to the interuall A I, the like hath the height L B to A B: I K is to A I in a ſeſquialiter proportion, whereupon it commeth to paſſe that A B yͤ meaſured longitude, cõtaineth B L the altitude once and a halfe: therefore if A B be 6. cubits, B L the altitude is 4: ſo that a third part of the ſaid A B is to be taken away, that the propoſed altitude B L may appeare.

Prædictorum confirmatio Geometrica, Eu. l. 4. 5. & 7. p. 6.

The reaſon of this and all other ſuch examples whatſoeuer, do hang on the equal proportion of angles & ſides of Tryangles: and that we may ſummarily, or compendiouſly comprehend all things before recited, behold A C D, and A B H together

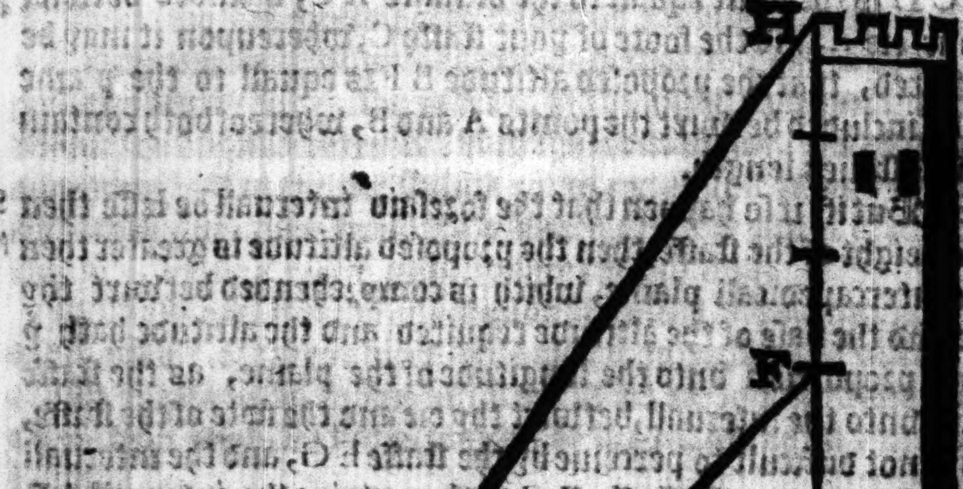
with

Ra.7.p.9.10,12

with A C K, and A B L, are alike equiangled: therefore as the ſide A C is to the ſide C D in the Tryangle A C D, ſo is the right line A B to B E: and alſo as A E is to E G, ſo is A B to B H: and as A I is to I K, ſo is A B to B L.

Orontius.

Relatiua relatiuis ſingulorum triangulorum, comparando latera.



CHAP.

Chap. X.

To fetch altitudes by the viſuall beames reflected into a glaſſe pleaſantly and with great facilitie.

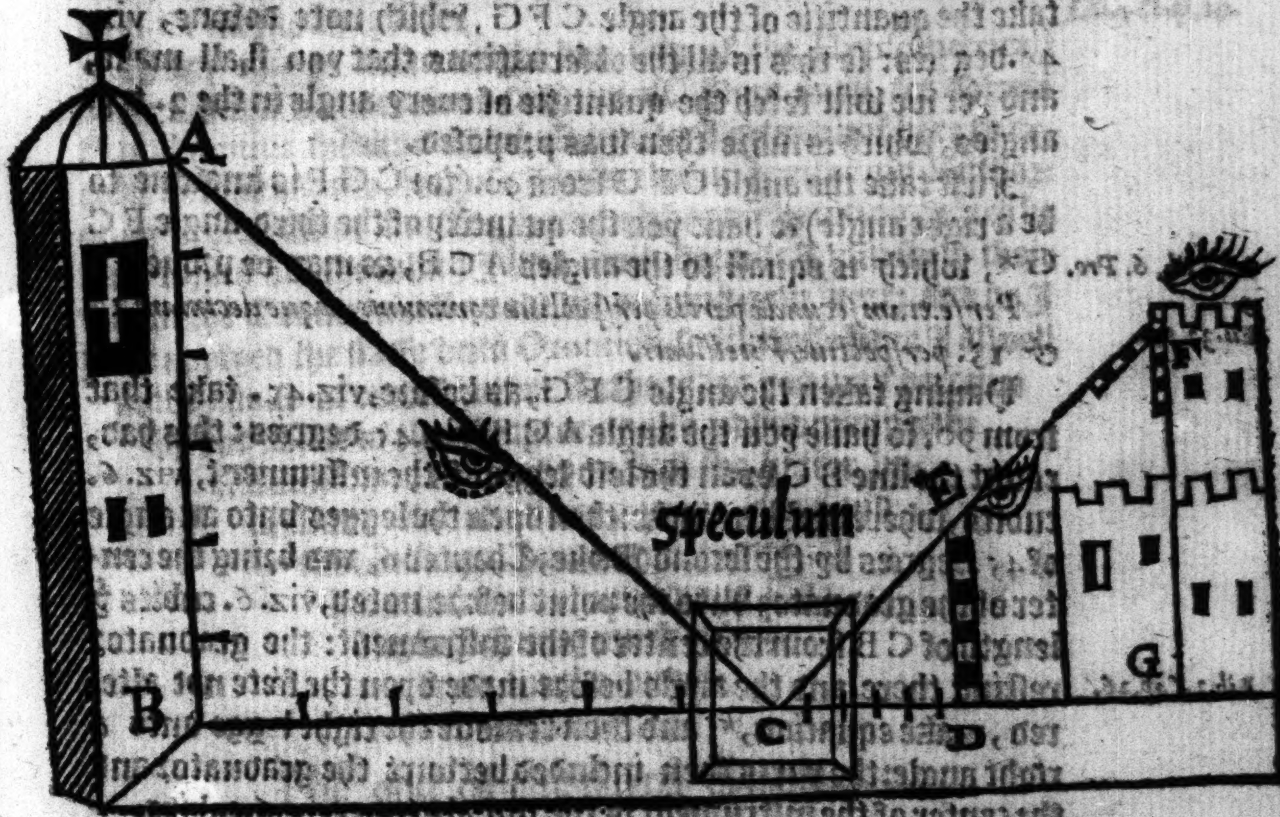
Orontius Chap. 10.

Altitude by a glaſſe.

Take a plaine glaſſe, and throw the ſame upon the ground, then depart from or draw neare thereunto, untill ſuch time as you ſee the top of the Tower in the glaſſe to anſwer with the top of your hollow ſtaffe held perpendicular: then meaſure the diſtance betwixt the foote of your ſtaffe, and the marke in the glaſſe where you fixed your eie; for ſuch proportion as the ſaid intervall or diſtance hath to the ſtaffe, the like hath the length from the glaſſe unto the baſe of the perpendicular, unto the height deſired.

Example.

Let A B be a Turret whoſe altitude is required, let the glaſſe be C, the center of the eie E, the ſtaffe erected perpendicular D E: therefore it commeth to paſſe, as C D is to D E, ſo is C B to B A: the altitude C D is 6. foote, and ſo is D E: therefore C B is equall to B A, C B is 6. yards, therefore C A is 6. yards; worke by the



29. Chapter of the ſecond Boke.

Chap. XI.

To fetch the altitude of a Tower or ſuch like, after a new way not ſpoken of heretofore, and that with great eaſe.

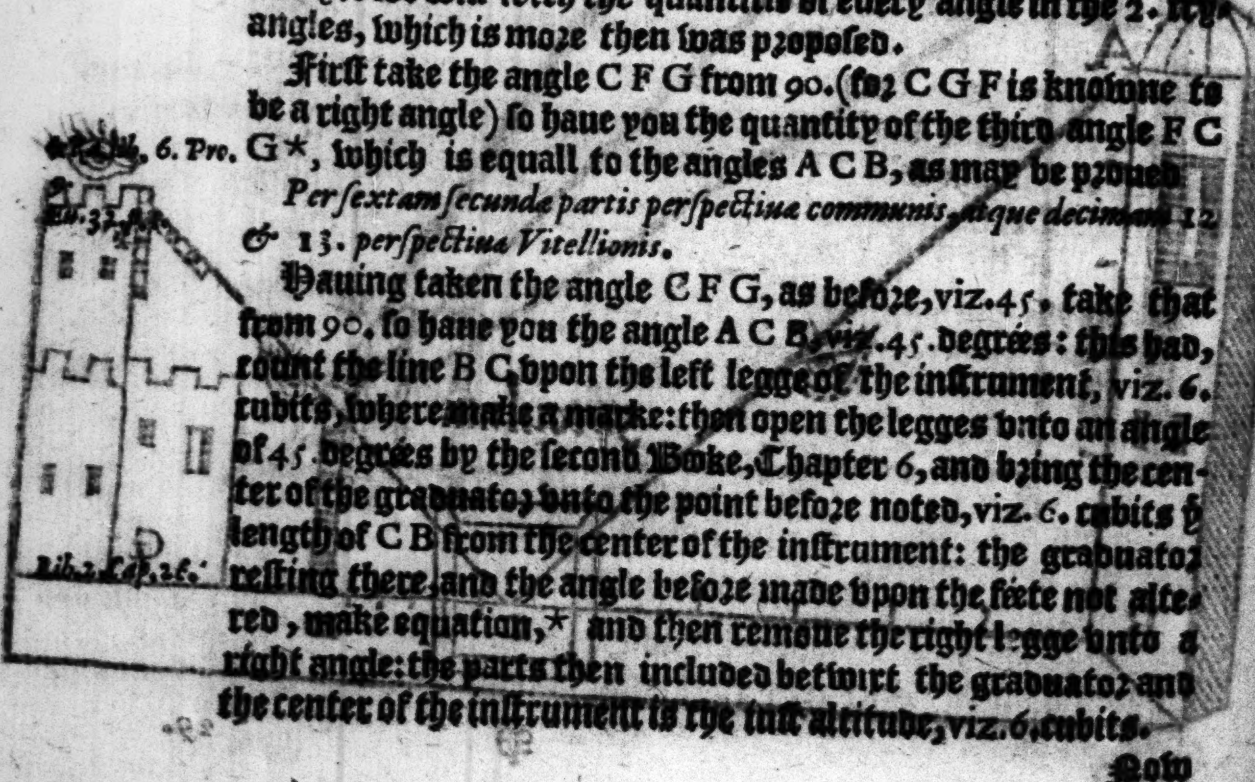
Altitude by a glaſſe.

SUppoſe that you were vpon the top of the Towre F, where you might behold another Towre, as A: now ſuppoſe there were a man ſtanding at C in the open field betwixt the two Towres A F, who deſired the altitude of the Towre A B, from the place where he ſtãds, he could tell you no more but how farre the Towre was from him, how farre from you he or the Towre was he could not tell, and yet he required the altitude: now imagine alſo you might not ſtirre frõ F to fetch ẏ altitude of F G, or the longitude of G C, nor G B to performe it by any propoſition heretofore, ſo then muſt you worke it in this maner.

Cauſe the man in the field to throw the glaſſe on the ground, iuſt where his feete were: then cauſe him to moue it vp or downe (keeping it parallell) vntill you ſee the top of the Towre A B reflected therein, ſo will the viſuall beames be A C F: then with the legges of your inſtrument by the 4. Chapter, Prop. 4. Booke 2. take the quantitie of the angle C F G, which note downe, viz. 45. degrees: ſo this is all the obſeruations that you ſhall make, and yet we will fetch the quantitie of euery angle in the 2. tryangles, which is more then was propoſed.

Firſt take the angle C F G from 90. (for C G F is knowne to be a right angle) ſo haue you the quantity of the third angle F C G*, which is equall to the angles A C B, as may be proued *Per ſextam ſecundæ partis perſpectiuæ communis, atque decimam 12 & 13. perſpectiuæ Vitellionis.*

* Lib. 6. Pro.



Eu. 32.

Lib. 2. Cap. 26.

Hauing taken the angle C F G, as before, viz. 45. take that from 90. ſo haue you the angle A C B, viz. 45. degrees: this had, count the line B C vpon the left legge of the inſtrument, viz. 6. cubits, where make a marke: then open the legges vnto an angle of 45. degrees by the ſecond Booke, Chapter 6, and bring the center of the graduator vnto the point before noted, viz. 6. cubits ẏ length of C B from the center of the inſtrument: the graduator reſting there, and the angle before made vpon the feete not altered, make equation,* and then remoue the right legge vnto a right angle: the parts then included betwixt the graduator and the center of the inſtrument is the iuſt altitude, viz. 6. cubits.

Now if you require the quãtitie of the other two angles, take 45. from 90, ſo haue you the angle B A C, becauſe the angle A B is knowne to be right.

In like maner, if the man had giuen you the altitude of the Tower, and required the diſtance thereof from him, it muſt haue béene performed as before, as you may perceiue, Lib. 2. Chap. 14. deſi. 2.

Chap. XII.

To fetch heights after another way (by their ſhadowe) then was ſpoken of before.

Erect your hollow ſtaffe perpendicular, and note the length of the ſhadow, then ſée what proportion it beareth vnto the ſaid ſtaffe: next meaſure the length of the ſhadowe of the thing, whoſe altitude is required: for ſuch proportion as the length of the ſhadowe had to the hollow ſtaffe, the ſame ſhall the ſhadowe of the altitude haue to the altitude it ſelfe.

Altitudes by their ſhadowe.

Example.

The ſtaffe is D E, his ſhadowe D C, the ſhadowe of the altitude is B C: therefore ſuch proportion as C D hath to D E, the like hath B C to B A: D E is equall to D C, therfore A B is equall to B C: worke as before.

Lib. 2. Chap. 29.

Many things more might bee ſaid of the Hypſometricall Scale: but it were tedious to write all. Here is all ſet downe that Orontius ſpeakes of, whoſe limits I intend not here to excéede in that behalfe, becauſe I haue choſen him for my Author: onely profundities and lengths in heights are wanting, which he hath wrote of, the which I here omit, becauſe I will ſhew their vſe in the Geometricall quadrant enſuing now next: and as I haue applyed the ſtaffe vnto Orontius, ſo likewiſe haue I aſwell made choiſe of diuerſe other Authors, as you may perceiue by the Title of the Chapter, as alſo added many new concluſions: & for that you ſhall the better vnderſtand the diuiſions, proportions and ſubdiuiſions herein contained, I haue inſerted a compendious Table, which may much enlighten a weake vnderſtanding.

The end of the third Booke.

A Generall Table of Number, declaring [n]ot onely all their kindes of number, and in what diui[ſ]ion or *ſubdiuiſion, any number whatſoeuer is comprehended: but* alſo ſundry varieties of proportion ariſing by the com*pariſon of numbers together, aſwell in quantitie* as in qualitie.

- Abſolute, which is
  - Solie, by themſelues.
    - Euen
      - Primes as two onely.
      - Compoūds
        - Euenly euen.
        - Vneuenly euen.
        - Perfect.
        - Imperfect.
          - abounding.
          - defectiue.
    - Odde.
      - Primes.
      - Compoūds
  - among themſelues. one to another.
    - Primes. Compoūds
      - vſually.
- Relatiue.
  - In quantitie.
    - Of difference.
    - Of Proportion
      - Of equalitie.
      - Of inequalitie.
  - In qualitie.
    - Of proportion.
      - Arithmeticall.
        - continuall.
        - diſcontinuall.
          - Proportion of equality is
      - Geometricall.
        - continuall.
        - diſcontinuall
          - Direct.
          - Conuerſed.
          - Alternate.
          - Inuerſed.
          - Compounded
          - Parted.
    - Of diſproportion.
- Figurall.
  - Linearie numbers;
  - Superficiall nūbers.
    - Triangular.
    - Circuler.
    - Square.
    - Long ſquare.
    - Like flats.
    - Diametrals.
    - Multiangular, &c.
      - The art of which numbers is called Arithmetick figurall not mentioned in this 3. Booke.
  - Solid numbers.
    - Cubes.
    - Squared ſquares.
    - Surſolids.
    - Zenzicubes, &c.
- Contract.
  - To vulgar quantities, as
    - Weight.
    - Meaſure.
    - Time.
    - Coine.
    - Men or beaſts.
    - &c.
      - not pertinent to this treatiſe.
  - To coſſick quantities
    - Figurall whoſe proper figures are
      - ſignifying an vnit or an ace.
      - ſignifying a Roote.
      - ſignifying a Square.
      - ſignifying a Cube.
      - ſignifying a ſquared ſquare
      - ſignifying a ſurſolide, &c.
        - all which belong alſo to arithmetick figurall.
    - or Radicall whoſe proper figures are
      - ſignifying a roote ſquare.
      - ſignifying a roote Cubicke.
      - ſignifying a roote Zenzizenzike.
      - ſignifying the roote ſquare of a roote ſquare.
      - ſignifying the roote ſquare of a Cubick roote.
      - ſignifying a roote vniuerſall, &c.
        - all which appertaine to arithmetick radical.

The branch moſt neceſſary for *this third and fourth Booke.*

- The greater which compareth the greater to the leſſer being
  - Simplex.
    - Multiplex.
      - Dupla, as 4 to 2. 6 to 3. 10 to 5.
      - Tripla, as 3 to 1. 6 to 2. 9 to 3.
      - Quadrupla, as 4 to 1. 8 to 2. 16 to 4.
      - Quintupla, as 5 to 1. 10 to 2. 15 to 3.
      - &c.
    - Superparticular.
      - Seſquialtera, as 3 to 2. 6 to 4. 9 to 6.
      - Seſquitertia, as 4 to 3. 8 to 6. 12 to 9.
      - Seſquiquarta, as 5 to 4. 10 to 8. 15 to 12.
      - Seſquiquinta, as 6 to 5. 12 to 10. 18 to 15
      - &c.
    - Superpartiens.
      - Superbitertias, as 5 to 3. 10 to 6. 15 to 9.
      - Supertriquartas, as 7 to 4. 14 to 8. 21 to 12
      - Superquadriqu. as 9 to 5. 18 to 10. 27 to 15
      - Superquintuſextas, as 11 to 6. 22 to 12.
      - &c.
  - Multiplex.
    - Multiplex ſuperparticuler
      - Dupla
        - ſeſquialtera, as 5 to 2. 10 to 4.
        - ſeſquitertia, as 7 to 3. 14 to 6.
        - ſeſquiq. as 9 to 4. 18 to 8. 11 to 5.
        - &c.
      - Tripla
        - ſeſquialt. as 7 to 2. 14 to 4. 19 to 6
        - ſeſquiter. as 10 to 3. 20 to 6. 22 to 7
        - ſeſquiq. as 13 to 4. 26 to 8. 25 to 8
        - &c.
      - Quadrupla
        - ſeſquialtera, as 37 to 9. 18 to 4.
        - ſeſquiter. as 41 to 10. 26 to 6.
        - ſeſquiquarta, as 17 to 4. 34 to 8.
        - &c.
    - Or multiplex ſuperpartiens.
      - Dupla
        - ſuperbitertias, as 8 to 3. 16 to 6.
        - ſupertriquar. as 11 to 4. 22 to 8.
        - ſuperquadri, as 14 to 5. 28 to 10.
        - &c.
      - Tripla
        - ſuperbitertias, as 11 to 3. 22 to 6
        - ſupertriquar. as 15 to 4. 30 to 8.
        - ſuperquadriq. as 19 to 5. 38 to 10
        - &c.
      - Quadrupla
        - ſuperbitertias, as 14 to 3. 28 to 9.
        - ſupertriquar, as 19 to 4. 38 to 8.
        - ſuperquadriquartas, as 24 to 5.
        - &c.
- The leſſer which compareth the leſſer to the greater
  - Simplex.
    - Submultiplex.
      - Subqua
        - dupla, as 2 to 4. 3 to 6. 5 to 10.
        - tripla, as 1 to 3. 2 to 6. 3 to 9.
        - drup. as 1 to 4. 2 to 8. 3 to 12.
        - quintu. as 1 to 5. 2 to 10. 3 to 15
        - &c.
    - Subſuperparticuler.
      - Sub
        - ſeſquial. as 2 to 3. 4 to 6. 8 to 12.
        - ſeſquiter. as 3 to 4. 6 to 8. 9 to 12
        - ſeſquiq. as 4 to 5. 8 to 10. 12 to 15
        - ſeſquiquinta, as 5 to 6. 10 to 12.
        - &c.
    - Subſuperpartiens.
      - Sub
        - ſuperbit. as 3 to 5. 6 to 10. 9 to 15
        - ſupert. as 4 to 7. 8 to 14. 12 to 21
        - ſuper. as 5 to 9. 10 to 18. 15 to 27
        - ſuperquintu. as 6 to 11. 12 to 22
        - &c.
  - Multiplex.
    - Submultiplex ſuperparticular.
      - ſeſquialtera, as 2 to 5. 4 to 10.
      - ſeſquitertia, as 3 to 7. 6 to 14.
      - ſeſquiquarta, as 4 to 9. 8 to 18.
      - &c.
      - Subdupla
        - ſeſquialtera, as 2 to 7. 4 to 14.
        - ſeſquitertia, as 3 to 10. 6 to 20.
        - ſeſquiquarta, as 4 to 13. 8 to 26.
        - &c.
      - Subquadrupla
        - ſeſquialtera as 2 to 9. 4 to 18.
        - ſeſquiter. as 3 to 13. 6 to 26
        - ſeſquiquar. as 4 to 17. 8 to 34.
        - &c.
    - Submultiplex ſuperpartiens.
      - Subdupla
        - ſuperbitertias, as 3 to 8. 6 to 16.
        - ſupertriquar. as 4 to 11. 8 to 22.
        - ſuperquadr. as 5 to 14. 10 to 28
        - &c.
      - Subtripla
        - ſuperbitertias, as 3 to 11, 6 to 22.
        - ſupertriquart, as 4 to 15, 8 to 30.
        - ſuperquadriqu. as 5 to 19. 10 to 38
        - &c.
      - Subquadrupla.
        - ſuperbitertias, as 3 to 14.
        - ſupertriquartas, as 4 to 19.
        - ſuperquadriquintas, as 5 to 24.
        - &c.

which is ſo much as

- $\frac{1}{2}$
- $\frac{1}{3}$
- $\frac{1}{4}$
- $\frac{1}{5}$
- $1\frac{1}{2}$
- $1\frac{1}{3}$
- $1\frac{1}{4}$
- $1\frac{1}{5}$
- $1\frac{2}{3}$
- $1\frac{3}{4}$
- $1\frac{4}{5}$
- $1\frac{5}{6}$
- $2\frac{1}{2}$
- $2\frac{1}{3}$
- $2\frac{1}{4}$
- $3\frac{1}{6}$
- $3\frac{1}{7}$
- $3\frac{1}{8}$
- $4\frac{1}{9}$
- $4\frac{1}{10}$
- $4\frac{1}{4}$
- $2\frac{2}{3}$
- $2\frac{3}{4}$
- $2\frac{4}{5}$
- $3\frac{2}{3}$
- $3\frac{3}{4}$
- $3\frac{4}{5}$
- $4\frac{2}{3}$
- $4\frac{3}{4}$
- $4\frac{4}{5}$

This proportion of the leſſer inequalitie is when the antecedent exceeds the conſequent, as 2 to 3, as 5 to 7, if you deuide 2 by 3, the quotient is 2 thirds, if 5 by 7, the quotient is 5 7 parts, ſo that this differeth not from the former, onely to euery name this word ſub is ioyned.

IRREGULAR.
PAGINATION.

BRITISH 16 JY 1902 MUSEUM

The end of the third Booke.

THE FOVRTH BOOKE of the Geodeticall Staffe, concerning the vſe of the Geometricall quadrant:

According as it is ſet downe by *Orontius*: ſo that in *practiſing by this ſtaffe, you may worke by the quadrant* it ſelfe at firſt inſpection; ſet downe both Arithmeticall, according to the ſaid *Orontius* do*ctrine, and mechanicall, agreeing to the vulgar capacitie.*

Chap. I.

To take the Horizontall diſtance of any marke from you, with or without the helpe of Arithmeticall calculation, and that at one ſtation.

Orontius, Chap.3.

Becauſe we will ſaue a labour in the cutting of new figures, we will take the demonſtration in the third Booke, Chap.2.

Let therefore the marke whoſe diſtance is required be F, the place where you ſtand E: where erect your ſtaffe at right angles with the ground line, by the third Booke, Chap.1. then take the angle of longitude F A E by the 2. Booke, Chap.4. Prop.1. next ſee what parts of the * geometricall quadrant are cut by the right point reſpectiue: for ſuch proportion as 60. hath to the parts cut, the like hath the length of the ſtaffe vnto the altitude.

Let the right point reſpectiue cut 15. parts at G, then ſuch proportion as 60. hath to 15, the like hath A E the ſtaffe to E F the longitude: 60 is to 15 in a quadruplate proportion: therefore A E muſt néeds containe E F 4. times, A E is foure foote, therefore

De metienda linea ſuper idem planum.

*vide lib.1.Pro 2.Defi.9.

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MUSEUM

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*vide lib.1.Pro. 2.Defi.9.

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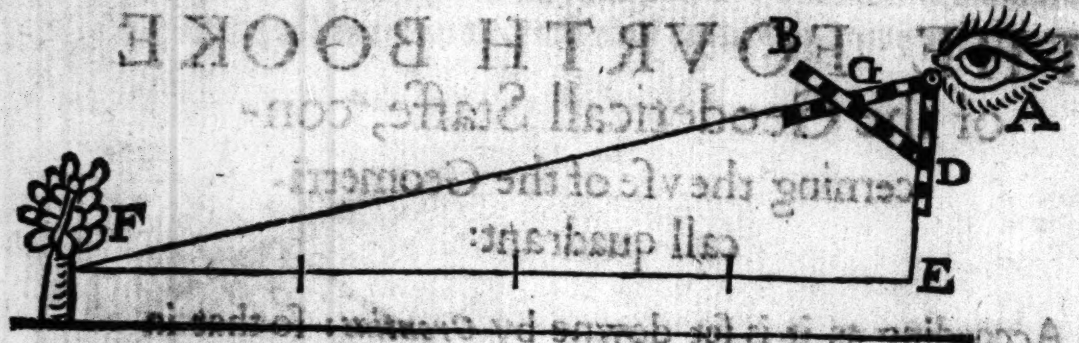
E F is 16 foote: beare this Prop. in minde, for he commeth often in vſe hereafter.

Example.



Hopt. And here we may worke better then Orontius, becauſe the ſtaffe in theſe operations repreſents ẏ one of the ſides of the quadrant, which by how much it is larger, by ſo much it workes truer then the quadrant.

*Lib.2.Chap.29.

And to put by Arithmeticke, worke * thus, ſaying: if 60. giue 15. what ſhall 4. giue?

Chap. II.

You ſtanding vpon the toppe of a Turret, to meaſure the diſtance of any marke ſeene before you on the ground.

Orontius. Chap.3.

Qualiter ex alto linea recta in plano metiatur,

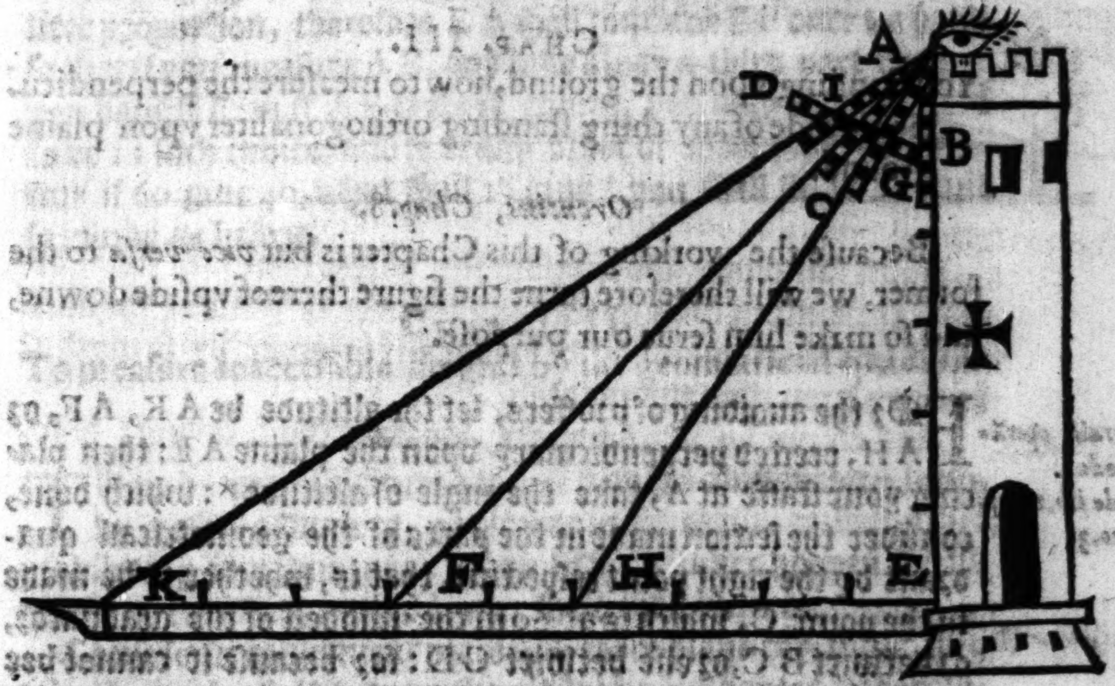
If thou ſtanding on the toppe of a Turret or any ſuch like, ẽ doeſt ſee any marke vpon ẏ ground, whoſe diſtance thou wouldeſt meaſure, the ground being plaine, and making right angles with the ſaid Turret, do thus.

Let the Turret be B E, the line propoſed E F, or E H, or E K, whoſe longitude from the foote of the Towre B is required by the geometricall quadrant.

Take therefore the angle of longitude by the firſt Booke, placing the left legge of your ſtaffe by the ſide of the Turret, and heauing vp the right legge vntill by the fiducial edge thereof, you ſee the marke, whoſe diſtance is required: then bring the graduator vnto the points reſpectiue, and note the parts cut in the geometricall quadrant: for either the ſection will be at C, which is the middeſt of the graduator, or betwixt B and C, or betwixt C and D, of neceſſitie.

1 First let the parts cut be in C, and let the propoſed line to be meaſured be E F; I ſay the line E F to be equall with A E ẏ the perpendicular, becauſe the graduator is cut in 60. parts at C therefore meaſure A E, ſo haue you E F; which happens ſo often as the point reſpectiue cuts the graduator at 60. parts.

Quando linea data æqualis eſt alti, ab oculo.



2 But if the ſegment by the right point reſpectiue be made betwixt B and C, as in G, then the propoſed line to bee meaſured E H, is ſhorter then the perpendicular A E, and hath ſuch proportion to the longitude E H, as 60 hath to the parts cut: therefore if B G be 40. parts, becauſe 60 is to 40 in a ſeſquialiter proportion, in the ſame maner A E ſhall containe E H once and a halfe: therefore meaſure A E by a thread, and take thence a third part of the length thereof, that is of A E; ſo haue you E H.

De linea eadem altitu, ab oculo minore.

Example.

As if A E were 24. cubits, then E H the deſired line ſhould be 16 cubits

Hopt. Or ſay, if 60 giue 40, what ſhall 24. giue?

Vide lib. 2, cap. 29.

3 But if the ſegment bee made betwixt C and D, as in I, and the line to be meaſured be E K, then the ſaid E K ſhall be longer then A E the perpendicular, and ſuch proportion as ẏ parts cut haue to 60, the like hath the altitude A E to E K, the propoſed longitude.

Cum eadem linea altitu, ab oculo ſuperat.

Example.

Let D I be 40 parts, 40 is to 60 in a ſeſquialiter proportion, whereupon the foreſaid E K containes A E once and a halfe; ſo as if A L be 24 cubits, E K is 36 ſuch cubits.

Hopr. Worke by the legges as before, ſaying: if 40 giue 60, what ſhall 24 giue? you finde 36 cut.

Chap. III.

You ſtanding vpon the ground, how to meaſure the perpendicular altitude of any thing ſtanding orthogonaliter vpon plaine ground.

Orontius, Chap. 8.

Becauſe the working of this Chapter is but *vice verſa* to the former, we will therefore turne the figure thereof vpſide downe, and ſo make him ſerue our purpoſe.

Generalis operãdi modus.

**Vide lib. 2. cap. 4. Pro. 3.*

For the auoiding of proffers, let the altitude be A K, A F, or A H, erected perpendiculary vpon the plaine A E: then placing your ſtaffe at A, take the angle of altitude*: which done, conſider the ſection made in the parts of the geometricall quadrant by the right point reſpectiue, that is, whether it be made in the point C, which is at 60 in the middeſt of the graduator, or betwixt B C, or elſe betwixt C D: for becauſe it cannot bee made in any other manner.

Quando linea data maior eſt intercapedine plani.

1 Firſt therefore let the ſection be made betwixt C D, as in I, and let the altitude to be meaſured be A K: then the altitude ſhall be greater then the ſpace intercepted betwixt thy ſtaffe and the baſe: and ſuch proportion as the parts cut haue to 60, the like hath the line A E to E K, the altitude.

Example.

As if D I were 40 parts, becauſe 60 to 40 is in a ſeſquialiter proportion, ſo likewiſe A E ſhall containe E K once and a halfe: therefore if A E were 18 cubits, E G muſt containe 27 ſuch cubits.

De linea æquali distantia ab oculo ad baſim.

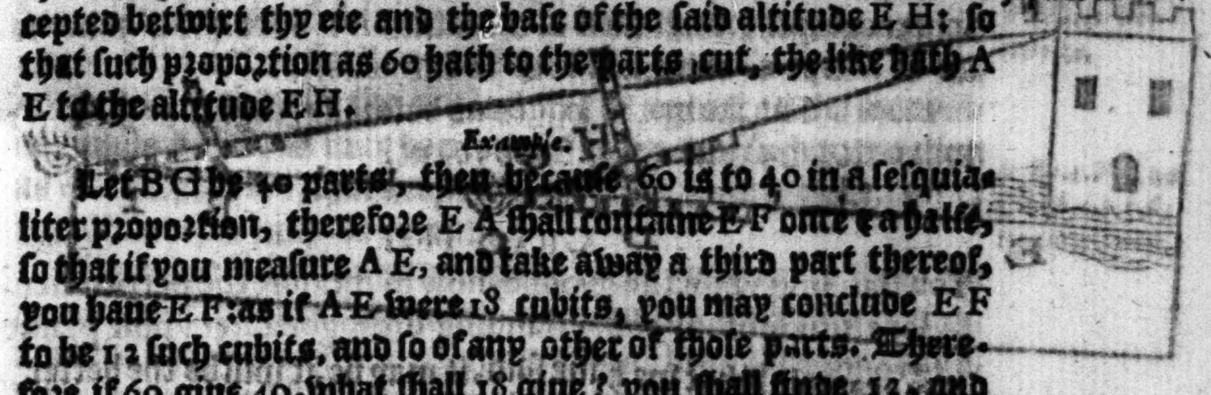
2 But let the parts cut be 60 in the point C, and let the altitude be E F: then ſuch proportion as the ſaid parts cut haue to 60, the like hath A E to E F.

Example.

A E is 18 cubits, therefore it may be inferred that the ſaid line E F propoſed to be meaſured, is alſo 18 ſuch cubits: therefore meaſure A E, ſo haue you E F.

3 When the foreſaid ſection is made betwixt C and B, as in G: then the propoſed altitude ſhall be leſſe then the line A E, intercepted betwixt thy eie and the baſe of the ſaid altitude E H: ſo that ſuch proportion as 60 hath to the parts cut, the like hath A E to the altitude E H.

Quando plani longitudo datam ſuperat altitud.



Example.

Let B G be 40 parts, then becauſe 60 is to 40 in a ſeſquialiter proportion, therefore E A ſhall containe E F once & a halfe, ſo that if you meaſure A E, and take away a third part thereof, you haue E F: as if A E were 18 cubits, you may conclude E F to be 12 ſuch cubits, and ſo of any other of thoſe parts. Therefore if 60 giue 40, what ſhall 18 giue? you ſhall finde 12, and ſo worke as before.

Chap. IIII.

To meaſure inacceſſible heights by the geometricall quadrant.

Orontius, Chap. 11.

There be many altitudes whoſe baſe we cannot come vnto, by reaſon of waters or ditches in the earth, or ſuch other prohibiting impediments: when ſuch altitudes happen whoſe height be required, in this maner ſhalt thou worke.

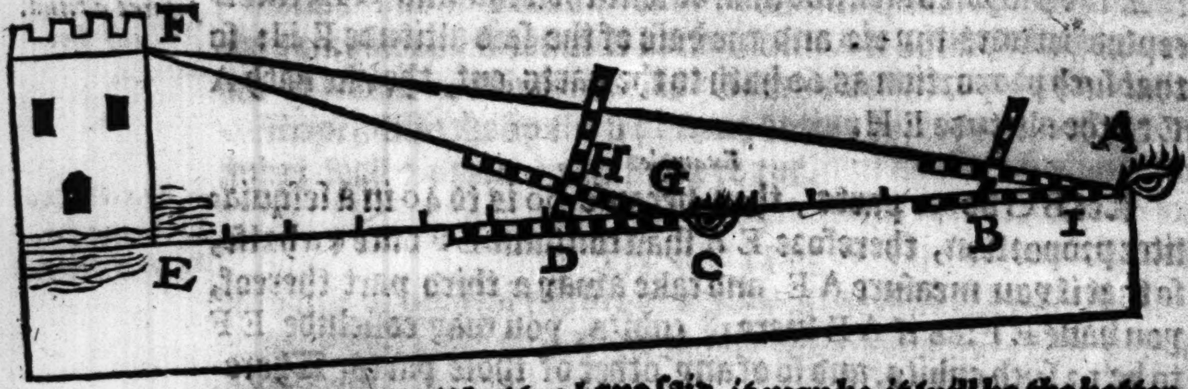
Operandi regula.

Chooſe ſome conuenient place, and there plant thy ſtaffe, and take the angle of altitude by the 2. Booke, 4 Chapter, as heretofore: then note the parts of the geometricall quadrant cut by the right point reſpectiue, obſeruing what proportion they haue to 60, and thoſe keepe in minde: then go direct backwards, or drawe neare vnto the altitude, euen as the aptneſſe of the place requires, and there againe plant thy ſtaffe, taking the angle of altitude: and then note the parts of the quadrant cut, and what proportion they haue to 60. Now conſider whether the parts kept at this ſtation of the firſt be greater, and then ſubtract the leſſer from the greater, & that which remaineth keepe in minde: then meaſure the interuall or ſtationary line, which diuide by yͤ former or occurrent number, which after ſubtraction was the denominator, and then the quotient thereof ingendred declareth the altitude.

Corolarium.

Whereupon if there were a vnite left, the interuall comprehended betwixt the two ſtations, is to be taken for the altitude: for becauſe a vnite neither in deuiding or multiplying, doth alter the number, as is ſaid before.

Example.



By example what we haue ſaid, it may be, it will be the better vnderſtoode; let therefore the propoſed Turret be E F compaſſed about with water, whoſe altitude is required: let the firſt angle of altitude be at G, and the parts cut vpon the graduator be D H, 20 at the point H: 20 to 60, is in a triple proportiõ, therefore keepe 3 for the denominator. This ſo done, go to the ſecond ſtation, viz. to I, and there againe take the angle of altitude, noting the parts cut, and then ſee what proportion they haue to 60: the parts cut here are 12, betwixt D K, at the point K: 60 to 12, is in a quintuplate proportion: therefore kéepe 5 for the ſecond denominator: next take 3 from 5, there remaineth 2, which kéepe for the vpright, next meaſure the diſtance G I, and let it be 24 cubits: which diuide by 2, ſo is the quotient 12: ſo many cubits high is E F the altitude.

Chap. V.

You being vpon the toppe of a high Turret or ſuch like, how to meaſure the altitude of any other Turret, though he be farre lower.

Orontius. Chap. 13.

Ex altiori breuiorem altitudinem metiri.

LEt the greater altitude be A E, from the toppe whereof you are put to meaſure the lower altitude G F: therefore place the left legge to point iuſt to F, and open the right leg to the angle F A G: the right and left legge ſo reſting, and pointing to the former markes, place a thread with a plumb at the end, in ſome part of the right leg, and to cut the left legge A D at what parts you will, as H I: then conſider what proportion A I hath to the part of the thread, intercepted betwixt the two legges of the inſtrument: for the ſame proportion ſhall the viſuall beame

A F haue to the propoſed and leſſe altitude F G.

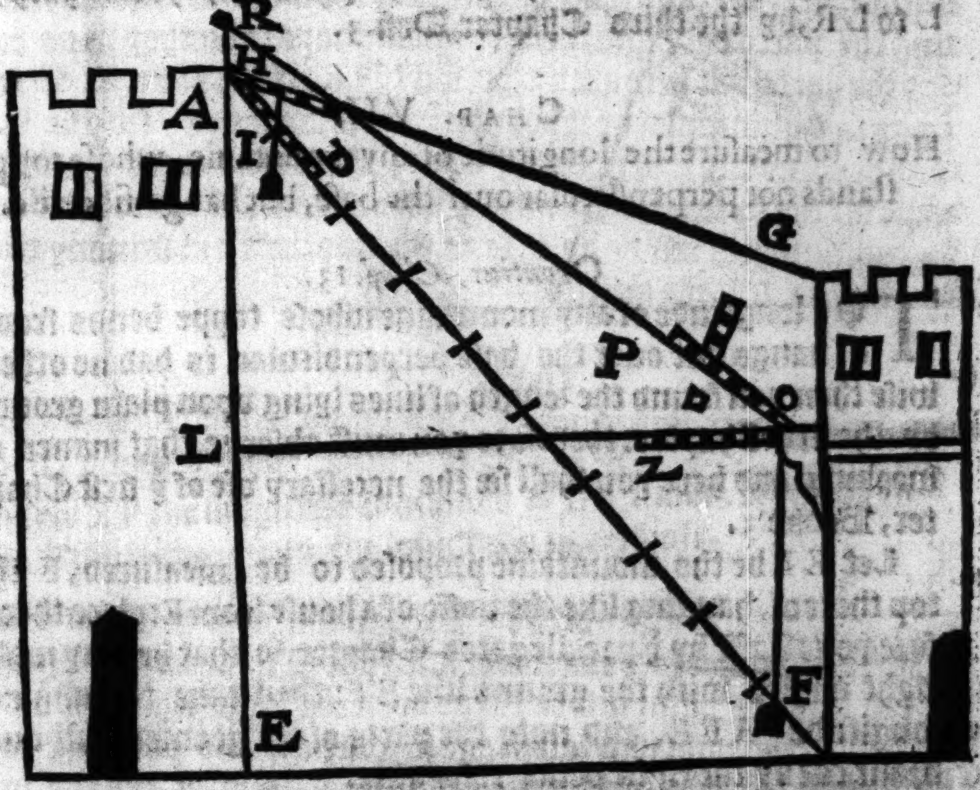
For there be two tryangles, A H I, and A F G, alike equall: & becauſe the angle at A is common to both the tryangles, and the angle A H I intrinſicall, and of the ſame parts is equall to the angle A G F, and alſo the angle A I H is equall to the intrinſicall angle A F G, as may be proued *: therefore ſuch proportion as A I hath to A H, that keepe: for A F ſhall haue the like, to F G the altitude, as may be proued.

Probatio Geometrica.

** Eu. 1. Pro. 29. Eu. lib. 4. p. 5. 6. Ra lib. 7 pro. 9.*

Therefore it ſhall be neceſſarie to teach you how to finde the quantitie of the line F A, which thou ſhall do after this maner: take the longitude of A E by ſome plumb line, then meaſure E F by the ſecond Chapter, or any other in this Booke: afterwards multiply A E and E F in themſelues quadrately, and reduce the product thereof into one number, and then extract the quadrant roote from the foreſaid aggregated number: for that ſhall be the ſide A F of the right angled tryangle A E F. For example, let A

Inuentio. Diagonalis.



E be 8 pearches, and E F 6: therefore 8 multiplied in 8, makes 64, afterwards 6 times 6 is 36: put 64 and 36 together, ſo will there reſult 100, the roote quadrature whereof is 10: therefore ſo many pearches A F; the thread H I in the middeſt of A D, the left legge, and A I, is double to I H: therefore A F is double to F G: ſo of conſequence F G is 5 pearches, ſuch as A F was 10.

Chap. VI.

To worke the laſt Chapter *verſa vice.*

Orontius, Chap. 13.

If you would worke the former Chapter contrarie, as to ſtād at O the leſſe altitude, and fetch R E the greater, do thus: place the left legge O Z to ly parallell, then heaue vp the right legge O P, vntill you haue taken the angle R O L: ſo O L E F is a parallelogram, whoſe oppoſite ſides are equall, as may bee proued*: therefore meaſure O F by a thread, ſo haue you L E: then take the length of E F by the 2 Chapter, ſo haue you O L by the former alledged reaſon:* then take the altitude L R by the third Chapter, which added to L E, the altitude appeares: for ſuch proportion as 60 hath to the parts cut, the like hath O L to L R, by the third Chapter, Defi. 3.

Eu. lib. 3. 4. p. 1.
Ra. 10. p. 6. conſ. 2

Chap. VII.

How to meaſure the longitude of any mountaine, whoſe toppe ſtands not perpendicular ouer the baſe, but hangs ſidewiſe.

Orontius, Chap. 13.

To ſeeke the height or length of moũtaines.

The longitude of any mountaine whoſe toppe bends from, or hangs not ouer the baſe perpendicular, is had no otherwiſe then you found the length of lines lying vpon plain ground by the firſt Chapter: therefore you muſt obſerue that maner of working: and here you ſhall ſee the neceſſary vſe of yͤ firſt Chapter, Booke 3.

Summarius operandi modus.

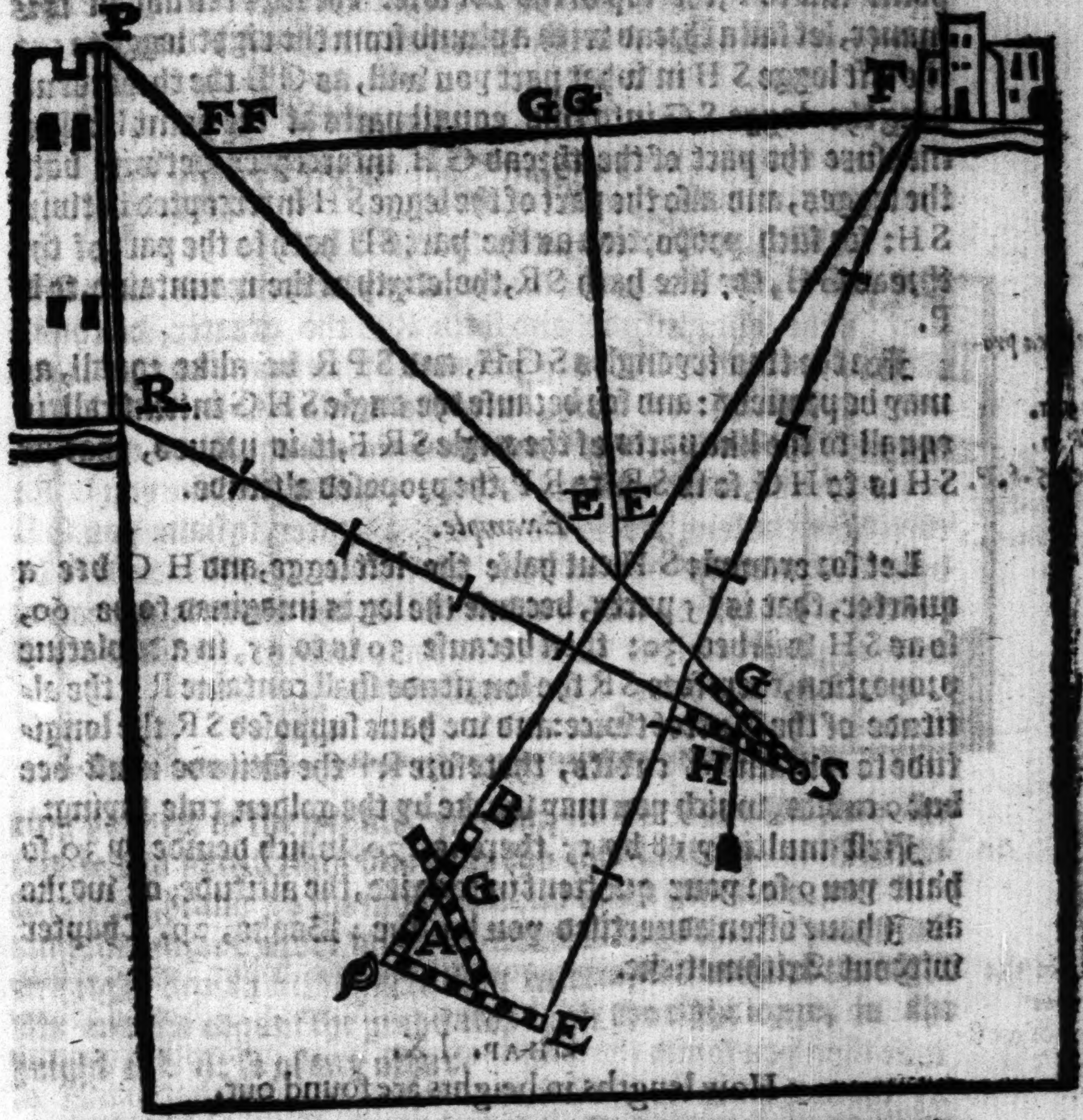
Let E F be the mountaine propoſed to be meaſured, F the top thereof, hanging like the roffe of a houſe from E: place therefore your ſtaffe by yͤ preallegated Chapter, ſo that he may make right angles with the ground line E F: then take the angle of longitude* A F E, and note the parts of the geometricall quadrant cut by the right point reſpectiue.

*Vide lib. 2. Chap 4. pro. 3.

For ſuch proportion as the parts cut haue to 60, the like hath the length of the ſtaffe to the longitude E F.

Example.

Let the right legge A B cut the graduator at 10 parts, viz. at G: then becauſe 60 to 10 is in a ſextuplate proportion, in like ma-



maner E F the longitude containes A E 6 times; whereupon if the ſtaffe were 4 foote, the longitude is 24 foote.

Chap. VIII.

To take the altitude of a Tower &c. placed vpon the toppe of a hill, or ſuch like.

Orontius, Chap. 15.

Quomodo altitudo linearum diſquiratur.

Let the Turret be P R, placed vpon the top of the mountain S R, then by the laſt Chapter, take the longitude of y mountaine S R, betwixt the foote thereof, and the baſe of the Towre, which let be 18: then turne the left legge S H to point full to the baſe of the Towre R, heaving vp the right legge S G, vntill he point iuſt to P, the top of the Towre: the legs reſting in this maner, let fall a thread with a plumb from the right legge to cut the left legge S H in what part you will, as G H the thread, deuiding the legge S G into two equall parts at the point H: then meaſure the part of the thread G H intercepted betwixt both the legges, and alſo the part of the legge S H intercepted betwixt S H: for ſuch proportion as the part S H hath to the part of the thread G H, the like hath S R, the length of the mountaine, to R P.

Geometrica probatio.
**Eu.29.1.*
Ra.7.P.9.
Eu.4 & 5.6.P.

For the two tryangles S G H, and S P R be alike equall, as may be proued*: and for becauſe the angle S H G intrinſicall, is equall to the like parts of the angle S R F, it is proued, that as S H is to H G, ſo is S R to R P, the propoſed altitude.

Example.

Let for example S H cut halfe the left legge, and H G bee a quarter, that is 15 parts, becauſe the leg is imagined to be 60, ſo as S H will bee 30: then becauſe 30 is to 15, in a duplatiue proportion, therefore S R the longitude ſhall containe R P the altitude of the Turret twice: and we haue ſuppoſed S R the longitude to containe 18 cubits, therefore R P the altitude muſt bee but 9 cubits; which you may worke by the golden rule, ſaying:

Firſt multiply 18 by 15, there is 270, which deuide by 30, ſo haue you 9 for your quotient ingendred, the altitude; or worke as I haue often aduertiſed you by the 2 Booke, 29. Chapter without Arithmeticke.

Chap. IX.

How lengths in heights are found out.

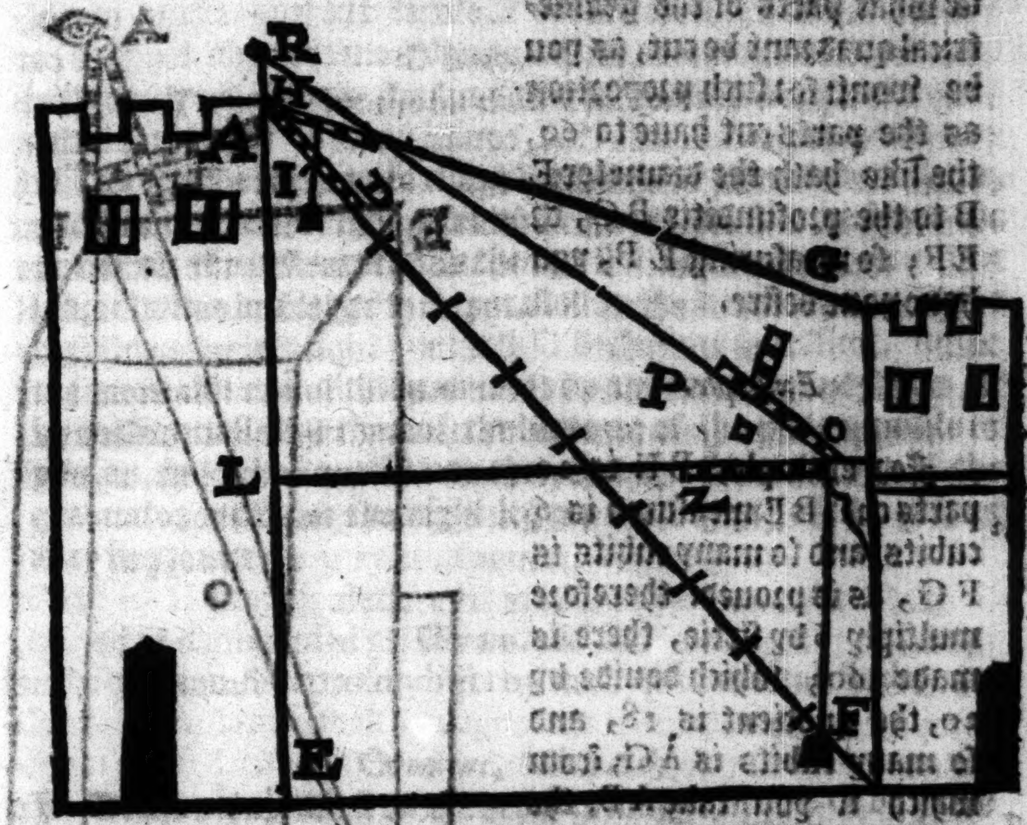
Orontius, Chap. 15.

Lengths in height are found.

WE will make ſhort of this Chapter, becauſe of his facilitie in working. Suppoſe that you were ſtanding at F, and deſired the length of A L in the altitude A E, firſt take the altitude of E L, then of E A; laſtly take the leſſer out of the greater, the remainder is your deſire.

To performe the ſame by the ſtaffe otherwaies.

Firſt take the height of L E as before, then open the legges vnto a right angle, turning the right legge towards the height, & holding the left parallell, then remoue the left ſight ſo farre from the center as you be from the baſe of the Tower; next remoue yͤ right ſite to the height of L E vpon the right legge: ſo you placing



cing your eie at the left ſite, you may ſe the right ſite, and the ſaid left to be in a right line with the ſaid latitude L: the legs ſo reſting, heaue vp the moueable end of the graduator, not ſtirring the center thereof, vntill the fiduciall edge thereof point iuſt in a right line to A: the parts then intercepted betwixt the right ſite and the edge of the graduator vpon the right legge, is the height of L A: ſo of any other.

Chap. X.

To take the depth or profunditie of any Well or ſuch like.

Orontius. Chap. 16.

I Haue often told you that profundities bee but reuerſed altitudes, therefore we will make ſhort of *Orontius*, and onely proceede to the matter.

Profunditie.

Let therefore the oblated pit be quadrangular B E F G, whoſe depth B G, or E F is propoſed to be meaſured: place therefore ÿ left legge to lie in a right line with B G: the reſting ſo, remoue the right legge vntill by the center A C, the ſite therein, you ſee the further ſide of the pit F, which is oppoſite to you at B: then point iuſt to P, the top of the Towre: the legs reſting in this maner, let fall a thread with a plumb from the right legge to cut the left legge S H in what part you will, as G H the thred, deui ding the legge S G into two equall parts at the point H: then meaſure the part of the thread G H intercepted betwixt both the legges, and alſo the part of the legge S H intercepted betwixt S H: for ſuch proportion as the part S H hath to the part of the thread G H, the like hath S R, the length of the mountaine, to R P.

Geometrica probatio.
*Eu.29.1.
Ra.7.P.9.
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Example.

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To performe the ſame by the ſtaffe otherwaies.

Firſt take the height of L E as before, then open the legges unto a right angle, turning the right legge towards the height, & holding the left parallell, then remoue the left ſight ſo farre from the center as you be from the baſe of the Tower; next remoue ÿ right ſite to the height of L E vpon the right legge: ſo you placing

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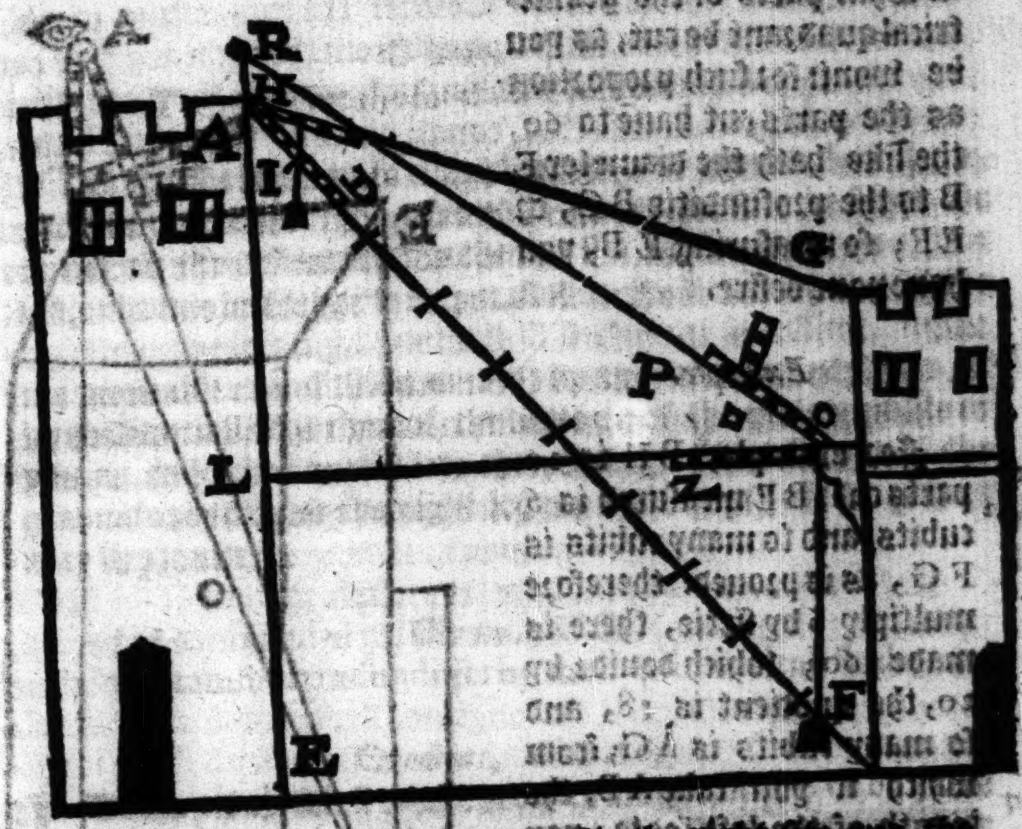


cing your eis at the left ſite, you may ſee the right ſite, and the ſaid left to be in a right line with the ſaid latitude L: the legs ſo reſting, heaue vp the moueable end of the graduator, not ſtirring the center thereof, vntill the fiduciall edge thereof point iuſt in a right line, to A: the parts then intercepted betwixt the right ſite and the edge of the graduator vpon the right legge, is the height of L A; ſo of any other.

CHAP. X.

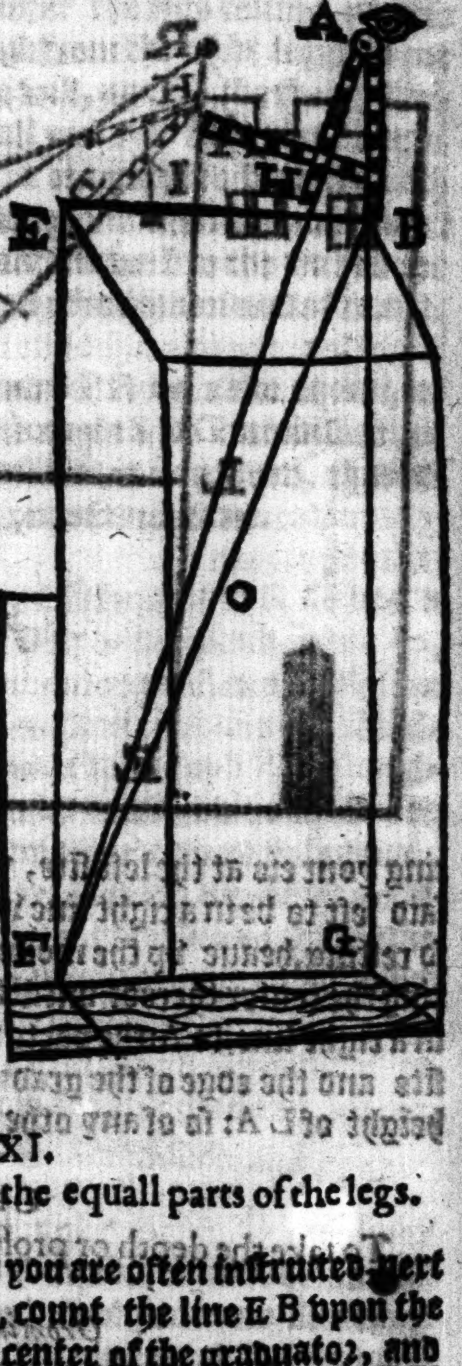
To take the depth or profunditie of any Well or ſuch like.

Orontius. Chap. 16.

I Haue often told you that profundities bee but reuerſed altitudes, therefore we will make ſhort of *Orontius*, and onely proceede to the matter.

Let therfore the oblated pit be quadrangular B E F G, whoſe depth B G, or E F is propoſed to be meaſured: place therefore ỹ left legge to lie in a right line with B G: he reſting ſo, remoue the right legge vntill by the center A C, the ſite therein, you ſee the further ſide of the pit F, which is oppoſite to you at B: then

Profunditie.



ſée what parts of the geometrical quadrant be cut, as you be wont: for ſuch proportion as the parts cut haue to 60, the like hath the diameter E B to the profunditie B G, or E F; ſo meaſuring E B, you haue your deſire.

Example.

Eu.lib.34.P.1. Ra.li.10.P.6.&.2 For example, B H is 20 parts cut, B E meaſured is 6 cubits, and ſo many cubits is F G, as is proued: therefore multiply 6 by ſixtie, there is made 360; which deuide by 20, the quotient is 18, and ſo many cubits is A G; from which if you take A B, the length of the left foote, you haue B G.

Chap. XI.

To performe the laſt Chapter by the equall parts of the legs.

*Lib.2,cap.4. P.4. FIrſt take the angle F B E * as you are often inſtructed, next meaſure the line B E; this done, count the line E B vpon the left legge, whereunto bring the center of the graduator, and then make equation,* not ſtirring the legges: which done, wreſt the ſcrew at the center of the graduator hard, ſo that the angle be not altered: laſtly remoue the right legge vnto a right angle, yͤ parts then intercepted betwixt the graduator and the center of the inſtrument, is the length of B G.

Lib.2,cap,26.

Chap. XII.

To performe the foreſaid Chapter otherwiſe.

Open the legge vnto a right angle, and there faſten them, remoue then the center of the graduatoꝛ ſo farre from the center of the inſtrument as the line B E ſhall inſtruct you; then place the ſaid left legge to lie parallell to the line B E, ſo will the right legge be in a right line with G B: the legs ſo reſting, moue the moueable end of the graduatoꝛ vp and downe, vntill you ſée by the fiduciall edge thereof, the bottome of the pitte oppoſite to you, as to E: the equall parts then that the fiduciall edge of the graduatoꝛ cut vpon the right legge, is the depth of the pit, as may be pꝛoued*.

En.4 & 5.P,6 R.7.P.9.

Chap. XIII.

To meaſure profundities by the hypſometricall Scale.

Orontius, Chap.16.

Let the pit oꝛ Well whoſe depth is ſought, be E B G F: place the left legge of your inſtrument A B to ſtand perpendicular vpon the line B G: then remoue the right legge vntill he point iuſt to the oppoſite and pꝛofundeſt part of the pit, as to F: which done, bꝛing the graduatoꝛ vnto the points reſpectiue, and note the parts of the hypſometricall ſcale cut: * next meaſure the line oꝛ diameter E B: foꝛ ſuch pꝛopoꝛtion as the parts cut haue to 12, the like hath E B the diameter to B G, the pꝛofunditie.

Profundities by the Hypſometricall ſcale.

*Lib.1.pro.2. Defi,10.

Example.

E B is 6 foote, the parts cut be 4: multiply 6 by 12, there commeth 72, which deuide by 4; there is 18 foote the depth of B G oꝛ E F: oꝛ woꝛke as I haue often inſtructed you, by the legges, ſaying, if 4 giue 12, what ſhall 6?

Chap. XIIII.

To fetch aſwell the length of the ſides, as alſo the perpendicular depth of any value or ſuch like.

Orontius, Chap.17.

It is auaileable oftentimes to know the depth and latitude of vallies, oꝛ ſuch like, which you ſhall doe in this maner.

Let the vallie be F, EE, FF, ſuch as they be wont to dig about the

the walles of Citties, whoſe greateſt latitude F, FF is required, and alſo his greateſt profunditie GG, EE: take therefore the longitude of D E by the ſecond Chapter, which let be 18 cubits: then by the doctrine of the ſaid ſecond Chapter, take the dorſine longitude, or the length of F, EE, which let be 15 cubits.

De vallis aut foſſa latitudine.

Multiply then 15 in it ſelfe, and there is made 225, afterward multiply the halfe of F, FF in it ſelfe, that is F, GG, 9 cubits; and there ariſeth 81: take then 81 from 225, there remaineth 144, ÿ quadrant rote whereof is 12: ſo many cubits may you conclude the profunditie GG, EE to be, ſo of any ſuch like.

And here we will conclude this fourth Booke, together
with the firſt Booke of Orontius, preſuming that
there can no right line happen howſoever
ſcituate, but he may be meaſured by
the doctrine beforeſaid.

The end of the fourth Booke.

THE

THE FIFTH BOOKE OF the Geodeticall Staffe, containing the vſe of the Iacobs ſtaffe, together with the working of the Golden rule by ſcale *and compaſſes without Arithmeticke.*

Alſo you are taught to worke the rule of proportion after
another way then in the ſecond Booke, that is, with
ſcale and compaſſe, with ſuch ſpeede as hath not beene
ſeene or heretofore publiſhed by any; alſo
it teacheth you the golden rule inuerſed, and
the double golden rule without Arith-
meticke, with the conſtruction of a new ſcale.

Chap. I.

Of the Iacobs ſtaffe, of the comparing him with the Geodetical ſtaffe, together with the things requiſite for to be obſerued in the vſe thereof.

The Iacobs Staffe is an inſtrument conſiſting of two rules made 4 ſquare, and truely tride: the longer of the two rules is called the Index or yard: the ſhorter is called the Tranſum, or Tranſuerſarium, that is the tranſuerſe or ouerthwart rule: for becauſe he muſt alwaies lie croſſe on ẏ yard, making right angles. The yard with ſome is deuided into 2100 equall parts, & the Tranſuerſe into 1000 ſuch like parts, with other leſſe, according as the vſe thereof occaſions them: the Tranſuerſe & the yard are coupled together, ſo that the one may moue along the other at right angles.

Deſcriptio Baculi Iac.

This inſtrument by ſome is ſaid to take his name of Iacob, grounding their reaſons vpon theſe words in the Bible, For

Nominatio Baculi Iac.

Gen. Cap. 32. with my ſtaffe came I ouer this Iorden: and the name might be
well taken, thence vpon diuerſe reaſons, though the ſtaffe hee vſed
there, be interpreted to no Mathematicall vſe: others ſay he
taketh his name of Iacob, for becauſe he was inuented of that
Patriarch himſelfe, or his vſe was moſt in requeſt about the
time of Iacob: and there is no one of theſe prealleagated reaſons,
but there may be ſufficient cauſes vrged to induce ſome credit
to the foundation of their opinions that ſo called the ſaid ſtaffe:
but howſoeuer, it is written of the better ſort, this inſtrument
Eſſe omnium reliquorum geodeticorum inſtrumentorum commodiſſimum,
* Lib. 9. Pro. 1. 2. 3. 4. 5. 6. 7. &c. which alſo is well demonſtrated by P. Ramus*. Now for
the affinitie that this ſtaffe hath to the Geodeticall ſtaffe, I ſay,
the equall deuiſions are alike vpon both, but thoſe of the legs
Lib. 2. cap. 1. no. 3 of my ſtaffe be not ſo many: notwithſtanding you be * inſtructed
to make them as many as you will, they alſo agree becauſe they
be both right angles: now the difference of theſe two ſtaues is
this, the Iacobs ſtaffe hath a tranſuerſe to moue along towards
or fromwards the end of the yard: which my ſtaffe hath not, but
is aſwell ſupplied by the ſite in the left legge, which doth repreſent
the yard: for you may mooue him towards or fromwards
the right legge at pleaſure, aſwell as you could the tranſuerſe vpon
the yard. The Iacobs ſtaffe hath alſo a yard to moue vp and
downe vpon the tranſuerſe, ſo that he may be neare vnto ẏ one
end, & further off the other end, or contrary, as occaſion requires.
My ſtaffe cannot doe ſo, howbeit you may moue the equicurrall
ſite in the right leg in ſuch ſorte, ſo that the right legge may ſupply
the vſe of the tranſuerſe in as good and eaſie ſort as the tranſuerſe
it ſelfe.

The things requiſite to bee obſerued herein, and in the vſe hereof, are no other then ſuch as be remembred in the 1 Chapter and ſecond Booke, in the end thereof: whereunto for breuities ſake I referre you, onely here the legges muſt ſtill be kept at a right angle by helpe of a pin put thorough the hole neare the center, for ſo much I entend in euery propoſition.

Chap. II.

Of the making of a new Scale, and to worke the golden rule thereby.

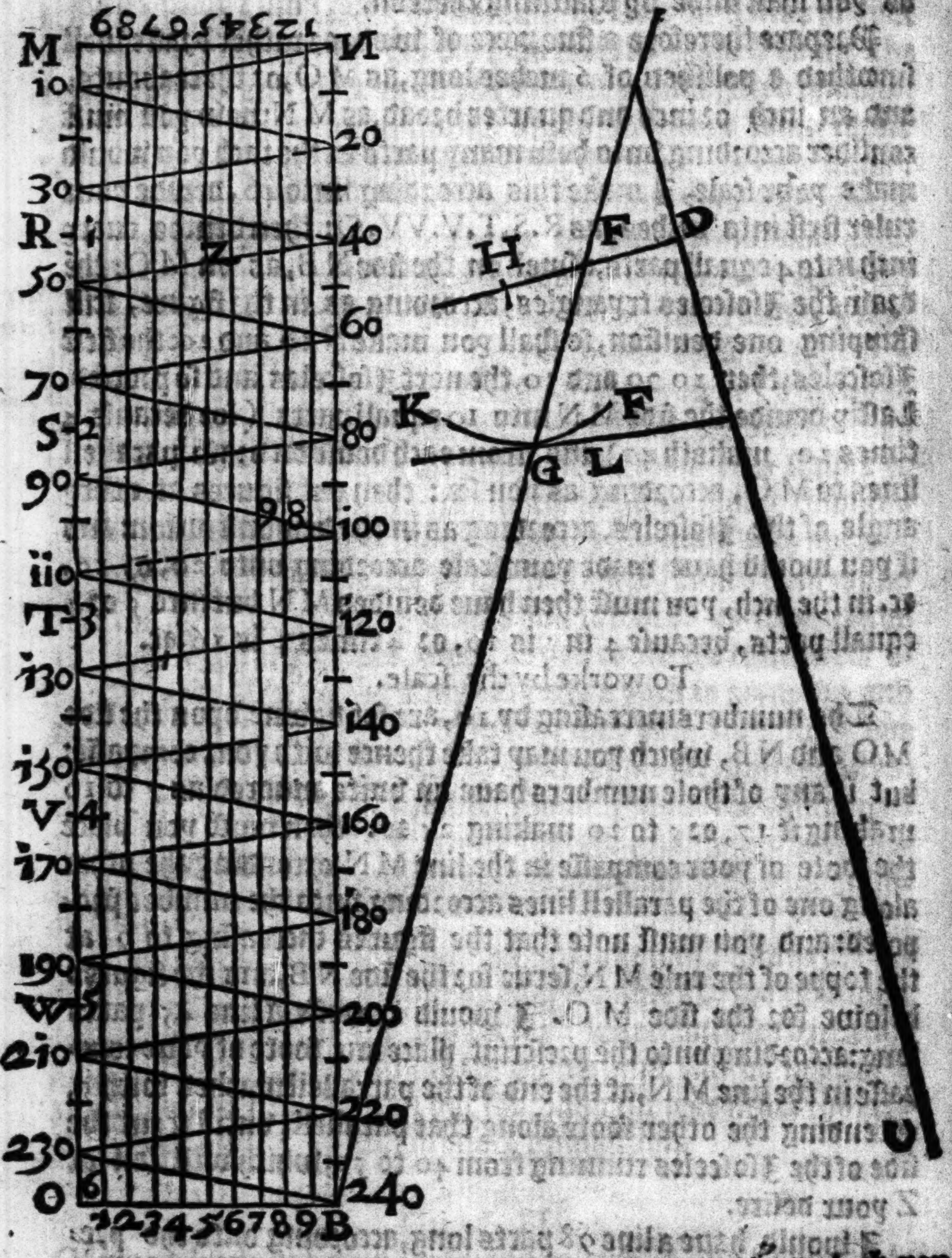
In my ſecond Booke I ſpake of the deliuering the 400 part of an inch, which I held no inſtrument could doe: howbeit I wil affirme, that by this ſcale you may giue the ſmalleſt part as can be required, and poſsibly laid downe: and indeede this kinde of ſcale aboue all others for exactneſſe and trueth is beſt, as you ſhall finde by practiſing thereon.

Prepare therefore a fine péece of wood, or rather braſſe well ſmoothed & poliſhed of 6 inches long, as M O, or thereabouts; and an inch or inch and quarter broad, as M N: now you muſt conſider according vnto how many parts in the inch you would make your ſcale, I make this according vnto 40, deuide your ruler firſt into inches, as R.S.T.V.VV.O: then deuide euery inch into 4 equall parts, aſwell on the ſide N B, as on M O; thẽ draw the Iſoſceles tryangles, according as in the figure, ſtill ſkipping one deuiſion, ſo ſhall you make N 10 and 20: the firſt Iſoſceles; then 10 20 and 30, the next Iſoſceles, and ſo procéed. Laſtly deuide the ſide M N into 10 equall parts (for becauſe 4 times 10 maketh 40) and from each deuiſion draw parallell lines to M O, according as you ſée: then put figures at euery angle of the Iſoſceles, according as in the demonſtration: and if you would haue made your ſcale according vnto 20, or 16, &c. in the inch, you muſt then haue deuided M N but into 5 or 4 equall parts, becauſe 4 in 5 is 20, or 4 times 4 is 16, &c.

To worke by the ſcale.

The numbers increaſing by 10, are ſet downe vpon the ſide MO and N B, which you may take thence with your compaſſe: but if any of thoſe numbers haue an vnite annexed, as 7 to 10 making it 17, or 5 to 20 making 25 &c. then muſt you place the foote of your compaſſe in the line M N, extending the other along one of the parallell lines according vnto the number propoſed: and you muſt note that the figures increaſing to 9 at the toppe of the rule M N, ſerue for the ſide N B, and the figures belowe for the ſide M O. I would expreſſe a line 45 parts long: according vnto the preſcript, place one foote of your compaſſe in the line M N, at the end of the parrallell marked with 5, extending the other foote along that parallell, vntill it cut the ſide of the Iſoſceles running from 40 to 50; which will fall at Z your deſire.

I would haue a line 98 parts long, according vnto the preſcript, I place the one foote of my compaſſe in the line M N, at the end of the parallell anſwering to 8 in the lower end O B, extending the other foote of my compaſſe to the interſection of that eight parallell, with the ſide of the Iſoſceles extended betwixt 90 and 100, which will fall out at the point marked with 98; which is your deſire, and ſo of all the reſt.


6 8 7 6 5 4 3 2 1
M
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W
5
200
210
220
230
O
6
240
1 2 3 4 5 6 7 8 9 B
H
F
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U

Now if you would apply this ſcale unto 20 in the inch, you muſt omit every other parallell, &c.

And note, the broader you make your ſcale, the truer ſhall your worke be.

The ruler made, you ſhall worke the golden rule thereby thus.

Draw two lines, which let interſect, making what angle you will at all aduentures, that is, it forceth not how big or little a quantitie ſo euer the angle be, as for the purpoſe B A C; theſe two lines ſo drawne vpon a faire ſheete of paper, of ſome ſmooth boord or ſlate &c. proceede thus,

To worke the golden rule.

Let the propoſition be, if 36 giue 72, what ſhall 40 giue?

Firſt with your compaſſe take the length of 36 degrées, and place that in the line A C (being one of the ſides of the foreſaid angle) by putting the one foote of your compaſſe in A, and extending the other towards C, and where he falles, make the point D: next take the third number giuen, that is 40, which taken with your compaſſe from your ſcale as before, place it in the line A B, the one foote of your compaſſe reſting at A, the other extended towards B, as to F: next draw a ſtraite line frõ D to F, and ſo beyond F at your pleaſure, then with your compaſſe take from your ſcale the length of your ſecond number giuen, 72, which place in the line A C, from A towards C, as at E: this done, from the point E drawe a line E G parallell to the line D F, (which you be after taught how to do,) but to finde the fourth number in proportion, I ſay it is already found: for note where the line E G interſects with the line A B, as at G: then take the length of A G, and apply it vnto the ſcale among the diuiſions, as you worked before: and ſo many equall parts as be contained betwixt the two féete of your cõpaſſe, ſo much is the fourth number in proportion, which you ſhall finde to be 80.

You ſhall draw the line G D parallell to D F thus: take yͤ length of D E with your compaſſe, the ſame wideneſſe remaining, place the one foote in the line F D at all aduentures, as at H: with the other deſcribe the portion of a circle, as K I: then * lay a rule vpon E, and the very edge of the I K, as at L: now by the fiduciall edge of your ſcale or rule, draw a ſmall ſtraite line as long as you will, viz, E G, which ſhall be parallell to F D, as may be proued *.

The ground of this working may be gathered from infallible Geometricall demonſtrations *.

* Eu. lib. 1. defi. 35.
Ra. lib. 2. P. 11. & Ra. 5. Pr. 11.
Eu. 2. P. 6. & 17. l.
Ra. 5. P. 13. con. 1 2 & 3.
Eu. 2 P, lib 6.
R. 8. P. lib. 6.

CHAP. III.

To worke the golden rule reuerſed, called in latine, Regula euerſa.

Regula euerſa.

This rule is termed reuerſed or inuerſed, when the queſtion is ſo propounded, that according vnto the courſe of numbers, the fourth ſhould ſurmount the third, and yet in reaſon it muſt needs be leſſe; or contrary according vnto courſe of numbers diminiſhing, when it ſhould increaſe: as for the purpoſe, if 12 Maſons can be able to make a certaine wall in 20 daies, how many ſhall make the ſame in fiue daies?

Here it is apparent that by courſe of numbers, as 12 is leſſe then 20, ſo the fourth ſought ſhould be leſſe then the third, and therefore conſequently much more then 12 daies: but reaſon teacheth that if 12 men be 20 daies about a peece of worke, if you would haue the ſame diſpatched in leſſe time, it is requiſite to haue more then 12 men; the courſe of numbers therefore, & the truth in reaſon being repugnant, you muſt worke by the rule of proportion inuerſed.

This reciprocall or conuerſed proportionalitie is ſuch a proportion, which beginneth with the firſt number, comparing it forwards directly, but not to the next terme, but vnto the third and then with the fourth or laſt terme, comparing it vnto the ſecond conuerſely, as it were backwards: as for the purpoſe, comparing theſe 4 tearmes before remembred, 12, 20, 5, 48, I ſay thus, as 12 exceedeth 5, ſo doth 48, 20. Whereby you ſee there is a true proportion; otherwiſe if the proportionall ſo termes had beene inferred as they ſtand, there had béene an vtter diſproportionality: therefore to worke this rule, we muſt reduce the numbers giuen into a direct proportion thus, not euerſed, put the third terme firſt, the firſt ſecond, and the ſecond laſt, ſo will they ſtand thus: if 5 giue 12, what ſhall 20? and ſo working by the doctrine of the ſecond Chapter, you ſhall finde 48 your demand: for as 5 is to 12, ſo is 20 to 48, or as 5 is to 20, ſo is 12 to 48; but conuerſed in direct proportion thus, they ſhould ſtand 12, 5, 48, 20, ſo as 12 is to 5, ſo is 48 to 20: ſo that by the preſcript you ſée, there is 48 men required to finiſh that wall in 5 daies, which 12 men were about 20 daies.

And this rule may be eaſily wrought vpon the legges of the ſtaffe, euen as it is here.

Another example.

If 20 men can undermine a [illegible] in 30 daies, how many will doe it in 8 daies?

The numbers { proposed 20 —— 30 —— 8
reduced to reverſed proportion, 20. 8 —— 30.
reduced to direct proportion, 8. 20. 30. Anſ. 75.

And here I could eaſily teach you to worke the double rule, but for becauſe we ſhall haue ſmall vſe thereof in theſe intended workes, and alſo for that the former operations well vnderſtood, the working thereof is very facill, we will here omit the ſame vntill we be further occaſioned that way by ſome fit incitation.

And here you muſt note that this kinde of working medleth not with fractions or irrationalities, for becauſe it is the office of geometry to proceed no further then to proue that there are irrationals medling onely with rationall and whole numbers. Infinite waies could I teach you to apply the vſe of this ſcale, as to finde out the proportion of lines one vnto another, to draw figures, maps, ſea-cards &c. proportional in a leſſe or greater figure, &c. all which wee will put ouer vntill I haue accompliſht my preſent intendements.

CHAP. IIII.

How many vvaies the Iacobs ſtaffe will performe Dimenſions; whereupon he dependeth, and what he requireth.

THe Iacobs ſtaffe findes out the height and length of any thing three ſeuerall waies, and breadths two waies; the two firſt waies require you to make obſeruations but once, the third way muſt be performed at two obſeruations, that is at two ſtations: and you muſt vnderſtand that all the meaſures performed vpon the Iacobs ſtaffe depend vpon three numbers giuen to finde out the fourth, whereby you may perceiue how apt the ſecond Chapter is to bee coupled to the vſe of this ſaid ſtaffe. Two of theſe giuen numbers are alwaies found vpon the ſtaffe of the one, vpon the Index or yard, the other vpon the Tranſuerſe: but in our working the one is vpon the right leg, the other vpon the left legge; the third number aſſigned in proportion is ſome thing which is meaſured: for in the meaſuring of lengths, heights, &c. you muſt haue ſome thing or other meaſured, which muſt be the third number in proportion; which numbers had, and all things conſidered, fall to worke thus.

CHAP. V.

By ſome knowne altitude to find out the vnknowne longitude at one ſtation.

Propoſition Bac. Iac.

Ra. lib, 9 P. 7. ex 21, P. optic. Eucl.

Si viſus ſit ab indicis recti in metam longitudinis: vt tunc erit ſegmētum indicis ad ſegmentum Tranſuerſarij, ſic menſoris altitudo ad quæſitam longitudinem.

If the ſight paſſe from the beginning of the index, being right to the thing meaſured, vnto the end of the length; as the ſegment of the index ſhall be vnto the ſegment of the Tranſuerſarie, ſo is the height of the meaſure vnto the length.

And here you muſt vnderſtand that by the height of the meaſurer, is not meant the height of the man that meaſureth ſimply, but the height or diſtance of his eie from the ground, be he vpon the ground or on a Towre, &c.

The Propoſition for my ſtaffe.

As the equall parts included on the left legge, betwixt the ſite and the center, are to the parts on the right leg included betwixt the ſite and the center, ſo is the length to the height, and contrarie.

E ſtatione vnica, longitudinem ignotam inuenire, ex alto.

Open therefore the legges of your ſtaffe vnto a right angle, and there ſtay them by putting a pin through yͤ hole neare to the center, as you may perceiue in the figure in the firſt Booke; this done, take away the graduator, for here wee haue no vſe thereof, and then proceede thus: place your ſtaffe with the legges, ſo that the left legge may lie parallell, and the right perpendicular: as you be wont * remoue the ſites in the right and left legge vntill they both agree in one right line frō your eie to the marke whoſe longitude is required; which done, note the equall parts included betwixt the two ſites, and the center vpon each leg; for ſuch proportion as the parts cut haue one to the other, the like hath the height to the length, or length to the height.

* vide lib. 2. cap. 17.

Example.

Suppoſe the parts included betwixt the ſite and the center vpon the right legge were 60, and the parts cut vpon the left legge by the ſite were 180, let the height of your eie from the ground be 4 yards: then worke with eaſe by the ſecond Chapter, ſaying, if 60 the parts included vpon the right legge, giue 180, the parts included vpon the left legge, what ſhall 4 yards giue? ſo ſhall you finde 12, & ſo many yards may you conclude the height.

In the ſame maner may you meaſure heights ſtanding below.

Chap. VI.

To meaſure lengths ſtanding vpon the ground at one ſtation.

Place your ſtaffe to make right angles with the ground line as * you be taught, the legs reſting at right angles (as they alwaies muſt) place the left legge to lie parallell, then remoue the ſites in both the legges, vntill they agree in a right line with the thing whoſe diſtance is required: then note the parts included betwixt the ſites and the center vpon the right and left legge; for ſuch proportion as the part cut vpon the right legge hath to the parts cut vpon the left legge, the ſame hath the height of your eie from the ground to the longitude.

* Lib. 3. cap. 1

Qualiter ex alto lineæ in plano metiatur.

Example.

Let the parts cut vpon the right legge be 20, and the parts of the left legge be 60, let the altitude of your eie be 4 foote: then ſay by the ſecond Chap. if 20 giue 60, what ſhall 4 giue? ſo ſhall you finde 12 foote, the longitude deſired.

Neither is it any matter whether the longitude be on plain ground or vpon hills, ſo as you place your ſtaffe at right angles with the ground line, as you haue * done before, as it is written.

Lib. 4. cap. 6.

Nec quidquam intereſt, ſiue longitudo ſit in ſubiecto plano, ſiue in aſcenſu deſcenſuve montis, ſurſum deorſumve collimando: dummodo index in lineam longitudinis ſit rectus.

Chap. VII.

By the knowne altitude to finde the vnknowne longitude at one ſtation, the left legge lying parallell, and the right ſtanding perpendicular.

Propoſition Bac. Iac.

Si viſus ſit ab initio Indicis paralleli in metam longitudinis: vt erit ſegmentum tranſuerſarii ad ſegmẽtum Indicis, ſic data ſeu cognita altitudo ad longitudinem. Ra.lib.9.P.8

If the ſight paſſe from the end of the Index, lying parallell vnto the thing meaſured, as the ſegment of the tranſuerſary ſhall be vnto the ſegment of the Index, ſo is the giuen height to the length.

The propoſition for my ſtaffe.

As the included parts vpon the right leg are to the parts included vpon the left legge, ſo is the giuen altitude to the longitude deſired.

PLace the left legge to lie parallell, and the right perpendicular, as before, and let the right legge be towards the perpendicular altitude, as in the ſecond Booke, Chap. 10. then moue the ſites vp and downe, vntill they be both in a right line with the altitude required: then note what equall parts be included betwixt the ſites in each legge, and the center for ſuch proportion as the parts included vpon the right legge haue to the parts included vpon the left legge, the like hath the altitude to the longitude deſired.

Example.

Suppoſe you had the height of a Caſtle giuen you, and you being in the field farre off, were required to tell the diſtance of the ſaid Caſtle, let the parts included vpon the right legge be 120, or 60, let the altitude of the Towre giuen be 400, or 20 feete, let the parts included vpon the left legge be 210, or 105: then if you worke by the ſecond Chapter, you ſhall finde the longitude or diſtance of the ſaid Towre from you to be 700, or 350 feete, and ſo of any other ſuch like.

CHAP. VIII.

By the knowne altitude to ſeeke any longitude at two ſtations, when you can worke by neither of the former waies.

Propoſitio Bacu. Iac.

Si viſus ſit ab initio tranſuerſarii paralleli, in metam longitudinis, per terminum Indicis recti ad metam in alto propoſitam: vt erit in Indice differentia maioris ſegmenti ad minus, ſic differentia inter primam & ſecundam ſtationem ad longitudinem quæſitam Ra.lib.9.Pro 9.

If the ſight paſſe from the end of the Tranſuerſarie beeing

parallel

parallell, &c. as in the index the difference of the greater ſegment is vnto the leſſer, ſo is the difference of the ſecond diſtãce vnto the length.

The Propoſition for my ſtaffe.

As the difference of the greater parts included vpon the right legge, is vnto the leſſer, the ſight paſſing from the end of the left legge, or any part thereof, ſo ſhall the length betweene both the ſtations be to the diſtance required.

In the Iacobs ſtaffe, here the yard ſtandeth perpendicular, & the Tranſ. parallell, notwithſtanding though wee haue appointed the left legge of our inſtrument to repreſent the yard, &c. yet let him lie parallell: as he was wont, for all is one.

Chooſe thee out therefore one ſtation as neare vnto the altitude as thou wilt, and there plant thy ſtaffe, ſo that the left leg lie parallell, and the right ſtand perpendicular, looking towards the altitude: then place thy eye at the end of the left legge, or in any place thereof, as you will, and looke by the very end of the left legge, or by the ſite therein placed any where, remouing the ſite in the right legge, vntill by the end of the left legge or ſite therein placed and the ſaid right ſite, you ſee the altitude or ſummite thereof: make a note in the right legge what parts the ſite cut, then the legges reſting at a right angle, and the ſites not ſtirred, go backwards in a right line from your firſt ſtation the further the better, and there againe plant your inſtrument as before *; then place your eie againe at the end of the left legge or the ſite therein, as you did before, drawing downe the ſite in the right legge vntill he be in a right line with your eie and the ſummite of the foreſaid altitude: note againe the parts of the ſaid right ſite then ſtands at: for ſuch proportion as the former parts where the ſite was at ẏ firſt ſtation, haue thereunto, the like hath the diſtance betwixt both the ſtations to the longitude required.

* *vide lib. 2. cap. 36.*

Example.

Suppoſe you make your firſt ſtation, placing your eie at the end of the left legge, and remoue the ſite in the right legge, vntill he be in a right line with the altitude; let the parts the ſites then ſtands at, be 72: then go backwards in a right line, which let be 40 feete, and there againe make collimation, drawing downe the ſite in the right legge, vntill he bee in a right line with your eie (placed at the end of the left legge) and the ſummite of the altitude, as before, let the parts the ſite then ſtands at, be 36: then muſt I take the leſſer out of the greater, viz. 36 from 72, there remaineth 36: therefore I conclude thus, if 36 the difference of the ſegments on the right leg giue 40 feete, then 72 muſt needs giue 8 feete, becauſe the propoſition ſaith, as the difference of the greater parts included, be to the leſſer, ſo is the diſtance betwixt my two ſtations to the length propounded, therefore worke by the ſecond Chapter.

You may performe the laſt Propoſition, and neuer remoue the ſite in the right legge, as you be there required.

Chap. IX.

By the knowne longitude to finde out the vnknowne altitude at one ſtation, the right legge being perpendicular, and the left parallell.

Propoſitio Bac. Iac.

Ra,lib,9,P,10, *Si viſus ſit ab initio Tranſuerſarii recti terminum altitudinis, per terminum indicis paralleli in metam altitudinis: vt erit ſegmentum Tranſuerſarii ad ſegmentum indicis, ſic longitudo data ad altitudinem.*

If the ſight paſſe from the end of the Tranſuerſarie beeing right, &c. as the ſegment of the Tranſuerſarie ſhall be vnto the ſegment of the Index, ſo is the length giuen vnto the heights.

For the Geodeticall Staffe, Prop.

If the ſight paſſe from the extremes or end of the left legge being parallell, or from any part thereof, as the parts included vpon the left legge are to the parts included vpon the right legge, ſo is the longitude giuen vnto the propoſed altitude.

Place the left legge to lie parallell, then place your eie at the end thereof, or in any part of the left legge, as at 60: then moue the ſite in the right legge, till he be in a right line with the left ſite: and the ſummite of the altitude: then note the parts cut, which let be 36: let the diſtance of the Towre from you be 20 feete, worke then by the golden rule, or the rule 2 Chap. ſo ſhal you finde the altitude 12 feete.

But if your feete were leuell with the baſe, you muſt adde hereunto the length of your hollowe ſtaffe, which is 4 foote, ſo the altitude would be 16 foote: for by this kinde of working you alwaies tell how much higher the ſummite is then the leuell of your eie, I meane that part of the altitude which is leuell with your eie.

CHAP. X.

By knowing of the breadth of any Pit, Well, Turret, &c. to fetch the vnknowne profunditie thereof.

Propoſitio, Bac, Iac.

Si *viſus ſit ab initio indicis paralleli in metam profunditatis: vt erit ſegmentum Tranſuerſarii ad ſegmentum indicis, ſic data longitudo ad profunditatem.* Ra.lib.9.con.10

If the ſight paſſe from the end of the Index being parallell vnto the thing meaſured, as the ſegment of the Tranſuerſarie ſhall be vnto the ſegment of the Index, ſo is the length giuen vnto the profunditie.

For the Geodeticall ſtaffe.

Propoſition.

If the ſight paſſe from the end of the right legge, beeing perpendicular, or from any part thereof, as the parts included vpon the left legge, are to thoſe parts included vpon the right legge, ſo is the breadth to the depth.

Place therefore the left legge to lie parallell, and the right to ſtand perpendicular in a right line with the profunditie: let the parts included vpon the right legge be 13, and let the parts included vpon the left be 5: let the breadth of the Well be 10 feete: then if 5 the parts of the left legge giue 13, what ſhall 10 giue? worke therefore by the golden rule, or according to the doctrine of the ſecond Chap. ſo haue you the depth from your eie to the bottome of the Well, which will be 26 feete: from which you muſt take the height of your eie aboue the mouth of the Well, which let be one foote, 6 inches: which taken from 26, there remaineth 24, ½ feete.

CHAP. XI.

By the giuen longitude to finde the vnknowne Altitude of any thing.

Propoſitio Bac. Iac.

Si *viſus ſit ab initio indicis recti in terminum altitudinis: vt erit ſegmentum indicis ad ſegmentum Tranſuerſarii, ſic data longitudo ad altitudinem.* Ra,lib,9,Pr,11

If the ſight paſſe from the beginning of the Index beeing right as the Tranſuerſarie, ſo is the aſſigned longitude vnto the height.

which let be 23 parts: then if 23 giue 30, 44 ſhall giue 57 feet, and $\frac{9}{23}$.

Chap. XIIII.

To finde out latitudes by 2 ſtations, that is, the diſtance betwixe two Townes, Turrets, &c.

Propoſition Bac. Iac.

Ra.lib,9.P.13. *Si viſus ſit ab initio Indicis recti, per pinnas Tranſuerſarii, in terminos latitudinis: vt erit Indice differentia ſegmentorum (per duplicē diſtantiam facta) ad differentiam ipſam ſtationum ſeu diſtantiarum, ſic interuallum primarum Trauſuerſarii ad latitudinem queſitam.*

If the ſight paſſe from the beginning of the Index, beeing right by the vaines of the Tranſuerſarie to the termes of the breadth: as in the Index the difference of the ſegment (made by the double ſtation) is to the difference of the diſtance, ſo is the diſtance of the vaines to the breadth.

IT would be ſomething troubleſome to teach, you to ſeeke out breadths after this Propoſition, therefore without any more trouble, performe them as you would an altitude: for which purpoſe the 9 Chapter ſhall at this time ſerue, becauſe I will haſte to that which is more ſingular, and performed with great eaſe, that is, the art of meaſuring ground, and fetching of longitudes, latitudes, &c. by protracting: and you ſhall note that you may performe the propoſition ioyned with perſpectiue in the former Bookes after great eaſe, by vſing this ſtaffe as a Iacobs ſtaffe: all which and farre more the ingenious practiſer will finde out with eaſe, whoſe ſtudies that way, I could wiſh my ſelfe preſent to further, to the vttermoſt of my abillitie: becauſe aiming at facilitie, I doubt I haue writē ſo rude, as it will ſéeme difficult to a iudiciall eie, not for that the matter is hard, but becauſe the method is harſh, in wanting of conuenient phraſes to explicate the ſame: but my excuſe is, that my penne was applyed to the vnderſtanding of the ignorant, and not for the ripe wits of the learned.

The end of the fift Boooke.

To the equall Reader.

FRiendly Reader, after I had finiſhed my former Bookes, I was drawn on, as well by diuerſe my friends, as alſo with a certaine affectation which I beare thereunto, for to ſet forth a Booke of the art of meaſuring grounds by this my new deuiſed inſtrument: for that I ſee daily errours continually practiſed, euen by thoſe which be in moſt practiſe: whereby it giues the ignorant occaſion, and not without cauſe, to bring in queſtion the truth of that infallible and noble ſcience of Geometrie, the miſtreſſe of all Arts. Let no one be offended though I affirm that all aſcending, or deſcending grounds heretofore laide downe *in plano* by the plaine Table, Theodelitus, &c. are falſly laid downe. If they followe the doctrine of anie one writer now extant, I know the rules they publiſh to caſt vp the contents, be true, but the rules they teach inſtrumentally to fetch the contents is falſe, as may appeare in the ninth Chapter of this Booke. Some it may be will ſay, we haue inſtruments ſufficient already, and then what needeth this? which I affirme alſo conditionally, that they adioine the vſe of the 11 Chapter of this Booke thereunto: but this let ſuch vnderſtand, that they haue not extant a better for portabilitie, and true rendring of the quantitie of an angle; for the whole inſtrument is to be carried in a ſmall walking ſtaffe, of one inch diameter in the biggeſt place. And as thereby thou art taught to platte and meaſure grounds, both Arithmeticall, & Mechanicall, ſo alſo haſte thou rules to know whether thou haue wrought true or falſe; which heretofore was neuer publiſhed, but thou left in that point, as it were to worke at randon, ſo that thou mighteſt hope to haue wel done, though thou hadſt no certaintie thereof. Then if this Book giue thee full ſatisfaction, and bring the art of meaſuring grounds vnto a perfect head in one entire volume, which neuer heretofore hath beene, accept him kindly, & giue the Author good words for his paines: & ſo I end, wiſhing my ſelfe preſent when any doubt happens to ariſe by meanes of haſty writing, or ill phraſed tearmes,

Arthur Hopton.

THE

THE SIXT BOOKE OF THE Geodeticall ſtaffe, containing the Arte of Geodeſia, or meſuring ground, deuided into two parts; the firſt moſt rarely and after ſundry new waies, teaching you to take the true platte of any peece of ground, according to the true proportion & ſymmetrie, without the help of needle, protractor or any other comberſome appendant, with the correcting of diuerſe errors heretofore practiſed.

Chap. I.

Of meaſuring of ground, and what inſtrument is moſt fit for the ſame.

MEaſuring or plotting of ground, is an Art of well meaſuring, and therefore it might be called Geometry, which properly ſignifies, ars bene metiendi. But we vnderſtād in the learning of Geometrie, we obtaine a theoricall knowledge, by the contemplating with demonſtations and figures; and in this arte of meaſuring ground, we haue as it were the actiue part by practiſe and vſe thereof: for which practiſe & vſe, there haue diuerſe men ſtudied to finde fit inſtruments for the true, eaſie and ſpéedy working thereof, amongſt whom I ſeem with the beſt to compare this Geodeticall ſtaffe, not doubting, hauing reaſon my iudge, but to ſhew ſufficient cauſe why this inſtrument ſhould be preferred. Let vs therefore enter into conſideration what is required of that inſtrument that ſhould take place, and that I hold to be, which can trueſt expreſſe the quantity of an angle, and render it againe: for ſo to doe is the drift of all inſtruments: then it reſteth to proue what inſtrument is beſt able to expreſſe the quantitie of an angle. Firſt for inſtruments guided with the néedle, I ſay they be vncertaine, be-

Ars metiendi.

The Geodeticall ſtaffe.

Propoſition.

Iſ the ſight paſſe from the extremes of the legges, or by any parts equally included on each legge, as they be equall one to the other, ſo is the longitude to the height, and contrarie; therfore the legges being opened to a right angle, as you be accuſtomed, if you draw neare or depart from the altitude (kéeping yͤ left legge parallell) vntill you ſée the top of the altitude by the two ends of the legges, then may you ſafely conclude the diſtance from you to the baſe of the altitude, to be equall to the altitude it ſelfe; alwaies adding the length of your eie aboue the baſe thereunto, and ſo would it come to paſſe, the ſight paſſing from any parts equally on each legge included.

Example.

Let the parts on the right and left legge included betwixt yͤ ſites and the center of the Inſtrument, be 60, and let the diſtāce of the Towre be 250 féete, and ſo working by the golden rule, or the ſecond Chapter, the altitude will alſo appeare to be 250 féete; to which adde 4 féete the length of my ſtaffe, ſo there is 254 féete the true altitude.

CAP. XII.

By the knowne part of ſome altitude, to finde out the whole altitude it ſelfe.

Propoſitio.

Si viſus ſit ab initio Indicis, per pinnas ſeu dioptras Tranſuerſarii & curſoris, in terminos notæ partis: vt erit interuallum pinnarum ad reliquum ſupereminentis Tranſuerſarii, ſic notæ deſuper altitudinis pars ad reliquam. Ra.lib,9,con.11

Iſ the ſight paſſe from the beginning of the Index, béeing right by the vanes of the Tranſuerſarie to the termes, as of ſome knowne parts; as the diſtance of the vanes is vnto yͤ reſt of the Tranſuerſarie aboue the Index, ſo is the part knowne vnto the remainder.

The Geodeticall ſtaffe.

Propoſition.

Iſ the ſight paſſe from the beginning of the left legge, by both the ſites in the right, to the termes of ſome knowne parts, as the parts included betwixt the two ſites are to the parts included betwixt the ſite neareſt to the center, and the center, ſo is yͤ knowne part of the altitude to the part vnknowne.

Place therefore both the ſites in the right legge ſtanding perpendicular: then ſet your eie at the end of the left leg, mouing the ſites in the right vntill they agrée with the extremes of the knowne parts of the altitude: note then the equal parts contained betwixt both the ſites, for as they are to the parts betwixt the lower ſite and the center, ſo is the altitude knowne to the reſt vnknowne.

Example.

Let the parts included betwixt the ſites be 20, and the parts betwixt the ſite and the center 30: let the knowne part of the altitude be 15 foote: I conclude by the former doctrine, that the part vnknowne is 22, $\frac{1}{2}$ féete.

Chap. XIII.

To finde the altitude of any thing by helpe of two ſtations.

Propoſitio, Bac. Iac.

Si viſus ſit ab initio Indicis recti in terminum altitudinis, vt erit in Indice differentia ſegmenti ad differentiam diſtantiæ (primæ videl. ac ſecundæ ſtationis) ſic ſegmentum Tranſuerſarii ad altitudinem. Ra.lib,9.P.12.

If the ſight paſſe from the beginning of the Index beeing right, as in the Index the difference of the ſegment ſhall be to yͤ difference of the diſtance, (that is, of the firſt and ſecond ſtation) ſo is the ſegment of the Tranſuerſarie vnto the height of the thing meaſured.

For the Geodeticall Staffe.

Propoſition.

If the ſight at two ſeuerall ſtations paſſe by two points in yͤ left legge, and by ſome one point in the right; as the difference of the parts vpon the left legge be to the diſtance of the two ſtations, ſo are the parts included vpon the right to the altitude deſired.

Hauing placed your ſtaffe as you be often inſtructed before, then put the ſite in the right leg at what parts you will, as at 44 parts; then make obſeruation at the firſt ſtation, and note the parts cut by ſite in the left legge; then go * backe a certaine ſpace, as 30 féete, drawing backe the ſite in the left leg, vntill againe the right ſite and hee agrée in one line with the altitude: note there alſo the parts included betwixt the place where your ſite was at the firſt ſtation, and where he now is; vide lib,2,ca,36 which let be 23 parts: then if 23 giue 30,44 ſhall giue 57 feet, and $\frac{9}{23}$.

Chap. XIIII.

To finde out latitudes by 2 ſtations, that is, the diſtance betwixt two Townes, Turrets, &c.

Propoſition Bac. Iac.

Ra.lib,9.P,13.

Si viſus ſit ab initio Indicis recti, per pinnas Tranſuerſarii, in terminos latitudinis: vt erit Indice differentia ſegmentorum (per duplicē diſtantiam facta) ad differentiam ipſam ſtationum ſeu diſtantiarum, ſic interuallum primarum Tranſuerſarii ad latitudinem queſitam.

If the ſight paſſe from the beginning of the Index, beeing right by the vaines of the Tranſuerſarie to the termes of the breadth: as in the Index the difference of the ſegment (made by the double ſtation) is to the difference of the diſtance, ſo is the diſtance of the vaines to the breadth.

IT would be ſomething troubleſome to teach, you to ſeeke out breadths after this Propoſition, therefore without any more trouble, performe them as you would an altitude: for which purpoſe the 9 Chapter ſhall at this time ſerue, becauſe I will haſte to that which is more ſingular, and performed with great eaſe, that is, the art of meaſuring ground, and fetching of longitudes, latitudes, ec. by protracting: and you ſhall note that you may performe the propoſition ioyned with perſpectiue in the former Bookes after great eaſe, by vſing this ſtaffe as a Iacobs ſtaffe: all which and farre more the ingenious practiſer will finde out with eaſe, whoſe ſtudies that way, I could wiſh my ſelfe preſent to further, to the vttermoſt of my abillitie: becauſe aiming at facilitie, I doubt I haue writē ſo rude, as it will ſeeme difficult to a iudiciall eie, not for that the matter is hard, but becauſe the method is harſh, in wanting of conuenient phraſes to explicate the ſame: but my excuſe is, that my penne was applyed to the vnderſtanding of the ignorant, and not for the ripe wits of the learned.

The end of the fift Boooke.

To the equall Reader.

FRiendly Reader, after I had finiſhed my former Bookes, I was drawn on, as well by diuerſe my friends, as alſo with a certaine affectation which I beare thereunto, for to ſet forth a Booke of the art of meaſuring grounds by this my new deuiſed inſtrument: for that I ſee daily errours continually practiſed, euen by thoſe which be in moſt practiſe: whereby it giues the ignorant occaſion, and not without cauſe, to bring in queſtion the truth of that infallible and noble ſcience of Geometrie, the miſtreſſe of all Arts. Let no one be offended though I affirm that all aſcending, or deſcending grounds heretofore laide downe in plano by the plaine Table, Theodelitus, &c. are falſly laid downe. If they followe the doctrine of anie one writer now extant, I know the rules they publiſh to caſt vp the contents, be true, but the rules they teach inſtrumentally to fetch the contents is falſe, as may appeare in the ninth Chapter of this Booke. Some it may be will ſay, we haue inſtruments ſufficient already, and then what needeth this? which I affirme alſo conditionally, that they adioine the vſe of the 11 Chapter of this Booke thereunto: but this let ſuch vnderſtand, that they haue not extant a better for portabilitie, and true rendring of the quantitie of an angle; for the whole inſtrument is to be carried in a ſmall walking ſtaffe, of one inch diameter in the biggeſt place. And as thereby thou art taught to platte and meaſure grounds, both Arithmeticall, & Mechanicall, ſo alſo haſte thou rules to know whether thou haue wrought true or falſe; which heretofore was neuer publiſhed, but thou left in that point, as it were to worke at randoni, ſo that thou mighteſt hope to haue wel done, though thou hadſt no certaintie thereof. Then if this Book giue thee full ſatisfaction, and bring the art of meaſuring grounds vnto a perfect head in one entire volume, which neuer heretofore hath beene, accept him kindly, & giue the Author good words for his paines: & ſo I end, wiſhing my ſelfe preſent when any doubt happens to ariſe by meanes of haſty writing, or ill phraſed tearmes,

Arthur Hopton.

THE SIXT BOOKE OF THE Geodeticall ſtaffe, containing the Arte of Geodeſia, or meſuring ground, deuided into two parts; the firſt moſt rarely and after ſundry new waies, teaching you to take the true platte of any peece of ground, according to the true proportion & ſymmetrie, without the help of needle, protractor, or any other comberſome appendant, with the correcting of diuerſe errors heretofore *practiſed.*

CHAP. I.

Of meaſuring of ground, and what inſtrument is moſt fit for the ſame.

Ars metiendi.

MEaſuring or plotting of ground, is an Art of well meaſuring, and therefore it might be called Geometry, which properly ſignifies, ars bene metiendi. But we vnderſtād in the learning of Geometrie, we obtaine a theoricall knowledge, by the contemplating with demonſtations and figures; and in this arte of meaſuring ground, we haue as it were the actiue part by practiſe and vſe thereof: for which practiſe & vſe, there haue diuerſe men ſtudied to finde fit inſtruments for the true, eaſie and ſpeedy working thereof; amongſt whom I ſeem with the beſt to compare this Geodeticall ſtaffe, not doubting, hauing reaſon my iudge, but to ſhew ſufficient cauſe why this inſtrument ſhould be preferred. Let vs therefore enter into conſideration what is required of that inſtrument that ſhould take place, and that I hold to be, which can trueſt expreſſe the quantity of an angle, and render it againe: for ſo to doe is the drift of all inſtruments: then it reſteth to proue what inſtrument is beſt able to expreſſe the quantitie of an angle. Firſt for inſtruments guided with the needle, I ſay they be vncertaine, be-this let ſuch vnderſtand, that they haue not extant a better for portabilitie, and true rendring of the quantitie of an angle; for the whole inſtrument is to be carried in a ſmall walking ſtaffe, of one inch diameter in the biggeſt place. And as thereby thou art taught to platte and meaſure grounds, both Arithmeticall, & Mechanicall, ſo alſo haſte thou rules to know whether thou haue wrought true or falſe; which heretofore was neuer publiſhed, but thou left in that point, as it were to worke at randon, ſo that thou mighteſt hope to haue wel done, though thou hadſt no certaintie thereof. Then if this Book giue thee full ſatisfaction, and bring the art of meaſuring grounds vnto a perfect head in one entire volume, which neuer heretofore hath beene, accept him kindly, & giue the Author good words for his paines: & ſo I end, wiſhing my ſelfe preſent when any doubt happens to ariſe by meanes of haſty writing, or ill phraſed tearmes,

IRREGULAR.
PAGINATION.

THE

THE SIXT BOOKE OF THE Geodeticall ſtaffe, containing the Arte of Geodeſia, or meſuring ground, deuided into two parts; the firſt moſt rarely and after ſundry new waies, teaching you to take the true platte of any peece of ground, according to the true proportion & ſymmetrie, without the help of needle, protractor or any other comberſome appendant, with the correcting of diuerſe errors heretofore *practiſed.*

Chap. I.

Of meaſuring of ground, and what inſtrument is moſt fit for the ſame.

Meaſuring or plotting of ground, is an Art of well meaſuring, and therefore it might be called Geometry, which properly ſignifies, ars bene metiendi. But we vnderſtād in the learning of Geometrie, we obtaine a theoricall knowledge, by the contemplating with demonſtations and figures; and in this arte of meaſuring ground, we haue as it were the actiue part by practiſe and vſe thereof: for which practiſe & vſe, there haue diuerſe men ſtudied to finde fit inſtruments for the true, eaſie and ſpeedy working thereof, amongſt whom I ſeem with the beſt to compare this Geodeticall ſtaffe, not doubting, hauing reaſon my iudge, but to ſhew ſufficient cauſe why this inſtrument ſhould be preferred. Let vs therefore enter into conſideration what is required of that inſtrument that ſhould take place, and that I hold to be, which can trueſt expreſſe the quantity of an angle, and render it againe: for ſo to doe is the drift of all inſtruments: then it reſteth to proue what inſtrument is beſt able to expreſſe the quantitie of an angle. Firſt for inſtruments guided with the néedle, I ſay they be vncertaine, becauſe

Ars metiendi.

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Chap. I.

Of meaſuring of ground, and what inſtrument is moſt fit for the ſame.

Ars metiendi.

MEaſuring or plotting of ground, is an Art of well meaſuring, and therefore it might be called Geometry, which properly ſignifies, ars bene metiendi. But we vnderſtãd in the learning of Geometrie, we obtaine a theoricall knowledge, by the contemplating with demonſtations and figures; and in this arte of meaſuring ground, we haue as it were the actiue part by practiſe and vſe thereof: for which practiſe & vſe, there haue diuerſe men ſtudied to finde fit inſtruments for the true, eaſie, and ſpéedy working thereof; amongſt whom I ſeem with the beſt to compare this Geodeticall ſtaffe, not doubting, hauing reaſon my iudge, but to ſhew ſufficient cauſe why this inſtrument ſhould be preferred. Let vs therefore enter into conſideration what is required of that inſtrument that ſhould take place, and that I hold to be, which can trueſt expreſſe the quantity of an angle, and render it againe: for ſo to doe is the drift of all inſtruments: then it reſteth to proue what inſtrument is beſt able to expreſſe the quantitie of an angle. Firſt for inſtruments guided with the néedle, I ſay they be vncertaine, becauſe the ſides which repreſents the one ſide of the angle vpon the inſtrument, be ſo ſhort, that the loſſe of a degree is neuer perceiued; ſo that when they come to protract with a large protractor, they produce moſt abſurd errors: for in a Theodelitus of 18 inches diameter, I ſay, the worke is with as much error as if he were but halfe a foote diameter: my reaſon is, becauſe that which repreſenteth the one ſide of the angle is ſo ſhort, that he hath no congruencie with the other, which is the Index. To what purpoſe ſalles it, to ſeeke the degrées of the one ſide in a large circle, and of the other in a ſmall circle? haply ſome will ſay, the néedle is but to fixe ſome part of the inſtrument iuſt vnder the Meridian, and then the Index ſerues in a large circle to expreſſe the angle of poſition, which I grant: but yet I ſay, the vncertaintie of a ſhort néedle produceth an error as before: as for the purpoſe, take an angle of poſition, and note it down, then let another, nay, come you your ſelfe and take the ſaid angle; againe I ſay, you ſhall hardly find him to agrée with the former: and what is the reaſon? firſt the vncertaintie of the néedle, whereby you are not able to place that part of the inſtrument vnder the Meridian as was before, then the disparallelitie of the planting of your inſtrument, &c.

But being made large, are as good.

This granted, to deſcend then vnto other inſtruments without néedles: let the ſmallneſſe of their diuiſions be a ſufficient argument of their vncertaintie without vrging further. Laſtly, to procéede vnto the Geodeticall ſtaffe, our now intended labour, whoſe ſufficiency it reſts to proue, which I had rather referre vnto the cenſure of the wiſe, then ſéeme to heape many words together in the praiſe thereof: but this I will ſay, that he ſhall with more ſpéede and truth fetch the quantitie of an angle, then inſtruments with néedles can. Firſt for ſpéede, while you be waiting for the motion of your néedle to ceaſſe, I will haue finiſhed, nay, before you haue planted your inſtrument parallell, for my inſtrument reſpects no parallelity at all: then for the yéelding vp of any true angle, I hope this inſtrument is beſt able to doe the ſame, becauſe his ſides be longeſt, and conſequently his degrées largeſt: but let theſe things paſſe, onely returne we to the briefe vſe thereof in meaſuring ground.

Chap.

Chap. II.

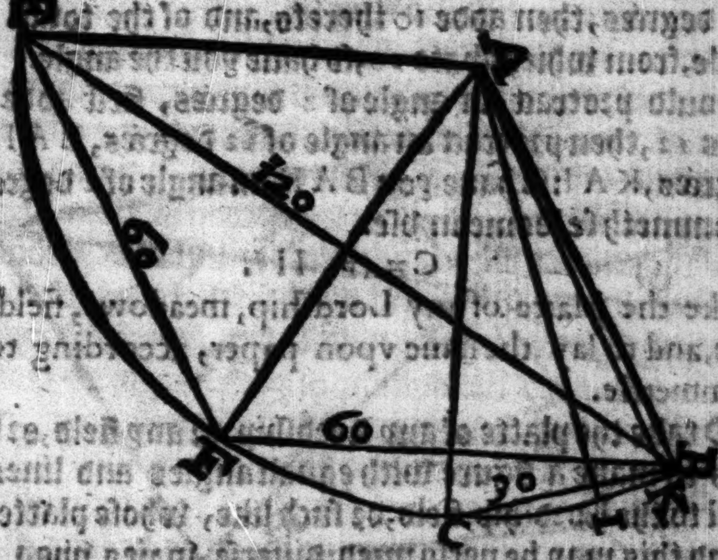
Of protracting of Angles, and finding out of the quantitie of angles protracted.

Protracting without a circle deuided.

FIrſt therefore to protract an angle, is to lay downe vpon yͤ paper an angle, iuſt to containe the number of degrees giuen: all angles in this inſtrument are protracted by the chords of a circle graduated vpon the backe ſide of the legs, in this manner.

Deſcribe a circle or a portion thereof, place then the ſemidiameter of the ſaid circle betwixt the two points reſpectiue, in yͤ points there made, as in the firſt Booke, Pro. 7: then take ouer in each legge the quantitie of the angle giuen, that is, place the one foote in the number of the angle giuen, vpon the one leg, and extend the other foote to the like number in the other leg, which place in the portion of the circle: ſo haue you the quantity of the angle, by drawing lines from the center to theſe 2 points made in the circle.

Example.



I would protract an angle of 30 degrees, firſt deſcribe a portion of a circle, as B D, vpon A the center: then I place the length of A B the ſemidiameter ouer in the points reſpectiue; next among the chord diuiſions, I take the diſtance ouer from 30 to 30, in each legge, which I place in the foreſaid circle, the one foote in B, the other in C: and then draw the line A B, and the right to B, and there take the quantitie of the ſaid angle A I B, as you be taught *, which I finde to be 39 degrees: next I direct the left legge towards B, and the right to C, & then take the quantitie of that angle as before, which I finde to be 67 degrees, B I C: then I direct the left foote to C, and the right to D, and take the quantitie of the angle C I D, which I find 56 degrees; ſo I proceede to all the reſt, and take their ſeuerall quantities, as of D I K, which I finde 16 degrees, of K I E, 30 degrees, of E I F, 20 degrees, of F I G, 9 degrees, of G I H 72 degrees: and laſt, of H I A, 51 degrees. Of theſe I make a Table, and ſet the ſame downe thus, with figures to ſhew which was the firſt, ſecond, third angle, &c.

Lib. 2. Cap 9, Prop. 2.

The quantitie of the angles of poſition or ſtation.

	Degrees.
1	39
2	67
3	56
4	16
5	30
6	20
7	9
8	72
9	51

Then I fall to meaſuring the ſeuerall diſtance of each angle from my ſtaffe, and note the ſame orderly downe by my angles of poſition: firſt I meaſure with a line from I to A, and finde it 27 pearches, then I meaſure from I to B, and finde it 9 pearches and ¾ parts: then I meaſure I C, and finde it 7 ¼ pearches, then I D, 19 pearches, I K, 12 ½ pearches, I E 28 pearches, I F 25 pearches, I G 14 pearches: and laſtly I H, which I finde to be 21 pearches, and theſe I ioyne to the former Table, thus.

The quantitie of each angle of ſtation.

	Ang.	
1	39	27
2	67	9 ¾
3	56	7 ¼
4	16	19
5	30	12 ½
6	20	28
7	9	25
8	72	14
9	51	21

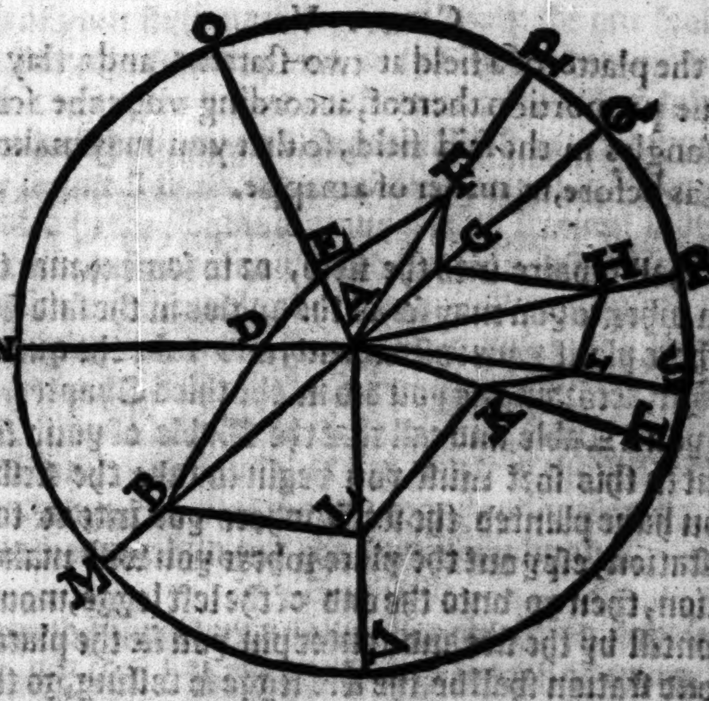
Sides of each angle.

Totall. } Proofe.

360 } Cap. 4.

This table taken, and in this order noted downe, you ſhall lay downe the plotte upon paper when you come home, or in ỷ field, if you pleaſe, ſo the weather be faire, thus.

Draw a line at all adventures, as A B: then taking from the legs of your ſtaffe, as is ſaid, or from your ſcale, the length of 27 pearches, which lay upon the ſaid line, A B; then protract by the ſecond Chapter an angle of degrees, as M A N: then protract an angle of 67 degrees, as N A O; then of 56 degrees, as O A P, then of 16 degrees, P A Q, and ſo round to all the reſt: then draw lines from each marke to the center A, M A, N A, O A, P A, Q A, R A, S A, T A, V A: next from your ſcale, take $9\frac{1}{2}$, & place that in the line A N, from A to D; then count $7\frac{3}{4}$ pearches in the line A O, placing the one foote at A, alwaies, as from



A to E: then from A to P, count 19 pearches, as to F, there make a marke: then from A to Q, count $12\frac{1}{2}$ pearches, as to G: doe ſo to all the reſt, ſo will A H be 28 pearches, A I, 25, A K 14, A L 21 pearches: then from B to D draw a line, then from D to E draw another line; doe ſo from E to F, from F to G, from the right to B, and there take the quantitie of the ſaid angle A I B, as you be taught *, which I finde to be 39 degrees: next I direct the left legge towards B, and the right to C, & then take the quantitie of that angle as before, which I finde to be 67 degrees, B I C: then I direct the left foote to C, and the right to D, and take the quantitie of the angle C I D, which I find 56 degrees; ſo I proceede to all the reſt, and take their ſeverall quātities, as of D I K, which I finde 16 degrees, of K I E, 30 degrees, of E I F, 20 degrees, of F I G, 9 degrees, of G I H 72 degrees: and laſt, of H I A, 51 degrees. Of theſe I make a Table, and ſet the ſame downe thus, with figures to ſhew which was the firſt, ſecond, third angle, &c.

Lib.2. Cap 9, Prop.2.

		Degrees.
The quantitie of the angles of poſition or ſtation.	1	39
	2	67
	3	56
	4	16
	5	30
	6	20
	7	9
	8	72
	9	51

Then I fall to meaſuring the ſeverall diſtance of each angle from my ſtaffe, and note the ſame orderly downe by my angles of poſition: firſt I meaſure with a line from I to A, and finde it 27 pearches, then I meaſure from I to B, and finde it 9 pearches and ¾ parts: then I meaſure I C, and finde it 7 ¾ pearches, then I D, 19 pearches, I K, 12 ½ pearches, I E 28 pearches, I F 25 pearches, I G 14 pearches: and laſtly I H, which I finde to be 21 pearches, and theſe I ioyne to the former Table, thus.

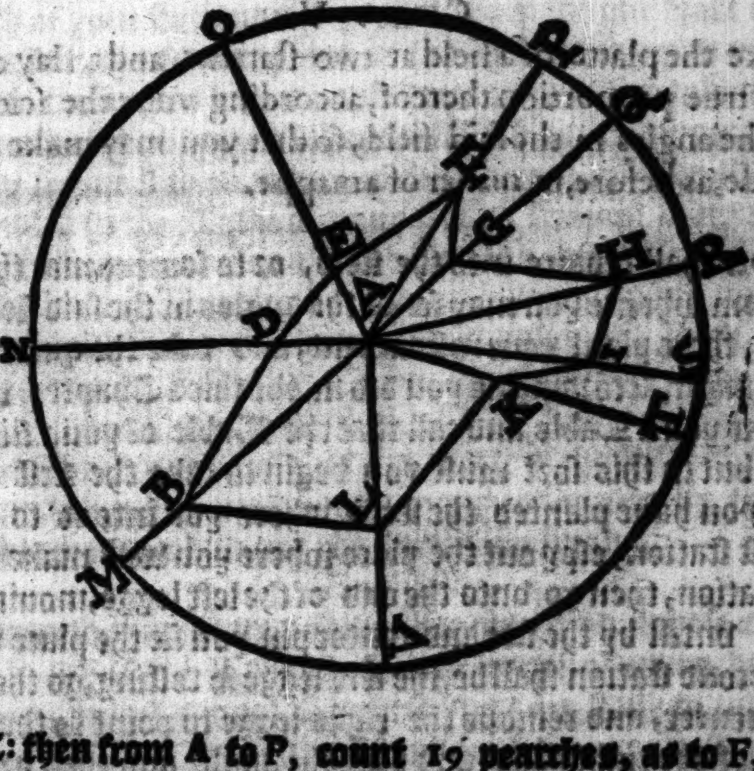
		Ang.		
The quantitie of each angle of ſtation.	1	39	27	Sides of each angle.
	2	67	9 ¾	
	3	56	7 ¾	
	4	16	19	
	5	30	12 ½	
	6	20	28	
	7	9	25	
	8	72	14	
	9	51	21	

Totall. } Proofe.

360 } Cap. 4.

This table taken, and in this order noted downe, you ſhall lay downe the plotte vpon paper when you come home, or in yͤ field, if you pleaſe, ſo the weather be faire, thus.

Draw a line at all adventures, as A B: then taking from the legs of your ſtaffe, as is ſaid, or from your ſcale, the length of 27 pearches, which lay vpon the ſaid line, A B; then protract by the ſecond Chapter an angle of degrees, as M A N: then protract an angle of 67 degrees, as N A O; then of 56 degrees, as O A P, then of 16 degrees, P A Q, and ſo round to all the reſt: then draw lines from each marke to the center A, M A, N A, O A, P A, Q A, R A, S A, T A, V A: next from your ſcale, take 9½, & place that in the line A N, from A to D; then count 7½ pearches in the line A O, placing the one foote at A, alwaies, as from



A to E: then from A to P, count 19 pearches, as to F, there make a marke: then from A to Q, count 12½ pearches, as to G: doe ſo to all the reſt, ſo will A H be 28 pearches, A I, 25, A K 14, A L 21 pearches: then from B to D draw a line, then from D to E draw another line; doe ſo from E to F, from F to G, from

G to H, from H to I, from I to K, from K to L, and laſtly from L to B, where you began: ſo haue you a platte agréeing in true Symmetrie to the former, the contents whereof, you may eaſily caſt vp in akers.

CHAP. IIII.

To know if your platte will cloſe, and whether you haue done true or not.

VVHen you haue ſet downe all your angles of ſtation, adde the ſaid quantitie together, according to the common order of addition, and if the totall ſurmount, or be vnder 360, you haue falſly done, and your platte ſhall neuer cloſe: as for the purpoſe, I adde the former angles together, and after addition, I finde the totall to be 360: which giues me warrãtiſe, I haue wrought truely, for if it had béene more or leſſe, my worke had béene falſe.

CHAP. V.

To take the platte of a field at two ſtations, and to lay downe the true proportion thereof, according vnto the ſcituation of the angles in the ſaid field, ſo that you may make a faire carde, as before, in maner of a mappe.

A platte taken at two ſtations.

YOu ſhall repaire into the field, or to ſome corner thereof, from whence you may ſée all the angles in the ſaid field, as before; there plant your inſtrument, and take the quantitie of euery angle, according as you did in the third Chapter, whereof make you a Table, and call that the Table of your firſt ſtation: but in this ſort muſt you begin to take the firſt angle: when you haue planted the ſtaffe where you intend to make the firſt ſtation, eſpy out the place where you will make the ſecond ſtation, then go vnto the end of the left legge, mouing the ſame, vntill by the ſite and center pin you ſée the place where your ſecond ſtation ſhall be; the left legge ſo reſting, go then vnto the center, and remoue the right legge to point to the next corner of the right hand, and take the angle, and then procéede as you be wont.

When you haue thus taken all the angles, and made a Table thereof, as I haue ſaid, take vp your ſtaffe, leauing ſome apparant marke, or ſome body to ſtand in the place where your ſtaffe was: then go you unto the place that you appointed before, for your ſecond ſtation, and there againe plant your ſtaffe, directing the end of the left legge to the firſt ſtation, or place where you left the foreſaid marke, and turne the right legge unto the angle or corner upon the right hand, taking the quantitie thereof: then proceede round about, taking the quantitie of every angle as you be accuſtomed, and note them all downe, making a Table thereof, which call the Table of your ſecond ſtation: this done, meaſure, or by ſome propoſition take the diſtance betwixt the two places where you made your obſervations, and note that line downe, which you ſhall call your ſtationarie line: this done, you ſhall take a faire ſheete of paper, on the middeſt whereof, drawe a ſtreight line croſſe over the paper, then towards the one end, make a point, which call your firſt ſtation, whereupon by the ſecond Chapter, protract all the angles noted in your firſt Table of ſtation, beginning at the line that you drew croſſe the paper, and proceeding rightwards round about: then take from your ſcale with your compaſſe yͤ length of your ſtationarie line, and apply the one foote of your compaſſe to the former point in the line, whereupon you protracted the angles before, and extend the other towards the other end of the line, and where he falleth, make a marke, which call the ſecond ſtation, whereupon as before, deſcribe all the angles noted in the Table of your ſecond ſtation: draw out the ſides of all theſe angles at both ſtations infinitely. Finallie, you ſhall note diligently the concourſe or croſſing of every line like line with his match, according as you noted them downe in their proper Tables, with figures of purpoſe, from which croſſing, if you draw lines, that is to ſay, from one croſſing unto the other, you have the true platte of the field: the length of every hedge, or part therein, may you meaſure by the ſcale, which before you laid out the ſtationarie line by.

Example.

Suppoſe there were a field to bee meaſured, whoſe corners were D E F G H I K, the platte and length of every hedge is here required: I cannot Traverſe from my ſtaffe to every angle in the field, by reaſon of ſome quabbes or marſh, or ſome ſuch like.

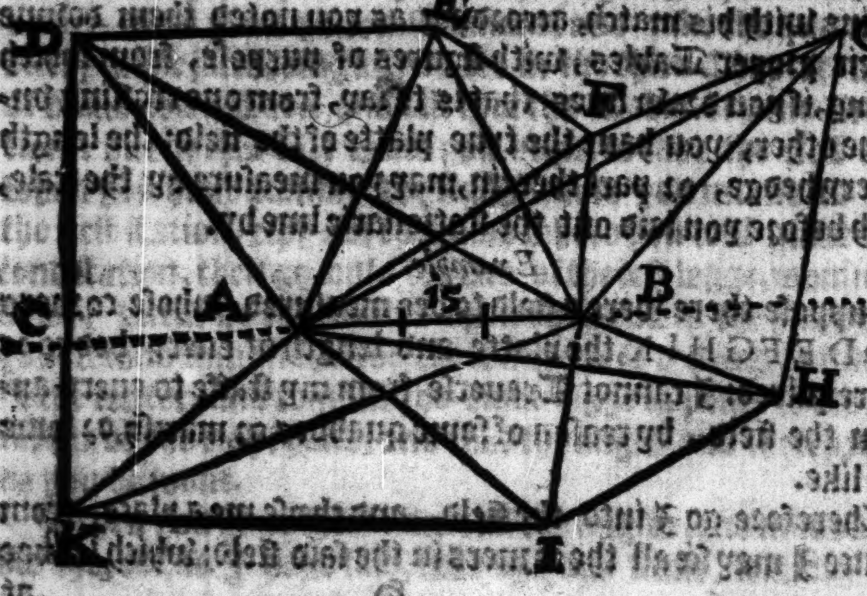
Therefore go I into the field, and chooſe me a place, from whence I may ſee all the corners in the ſaid field: which let bee at A: there I plant my inſtrument, and take notice of ſome other marke, whence alſo I may ſee all the corners in the ſaid field, which let be at B; now I open the legges, and go unto the end of the left legge, mouing the ſame about, untill by the ſight and the center I ſee to B: then I go unto the center, ſo that the end of the left legge point iuſt to C: then I direct the other legge to the firſt angle on my right hand, and ſo take the quantitie of the angle C A D, which I note downe in my Table of the firſt ſtation, viz. 57 degrees: then I take the angle D A E, directing the left foote to D and the right to E, which I find 62 degrees: this I note downe in my table for the ſecond angle, as in the table, and ſo I doe to all the other angles, and note them downe, viz. to the third, 4, 5, 6, 7 and 8, as E A F, F A G, G A H, H A I, I A K, and K A C: ſo ſhall you collect a Table in ſuch manner as I haue here ſet downe.

A Table of my firſt ſtation.

	Degrees.
1	57
2	62
3	33
4	14
5	27
6	41
7	90
8	36

Proue this Table by the 4 Chapter.

Totall 360 Degr.



I having thus done, I go unto my ſecond ſtation B, where turning the left edge to A my firſt ſtation, I take the angle A B D, 33 degrees, and note it downe in my Table of the ſecond ſtation; and ſo I proceede right hand to the ſecond, third, fourth &c. angles taking their ſeverall quantities, and noting it downe as before, as of D B E, E B F, F B G, G B H, H B I, I B K, K B A, ſo ſhall I haue made ſuch a Table as the former.

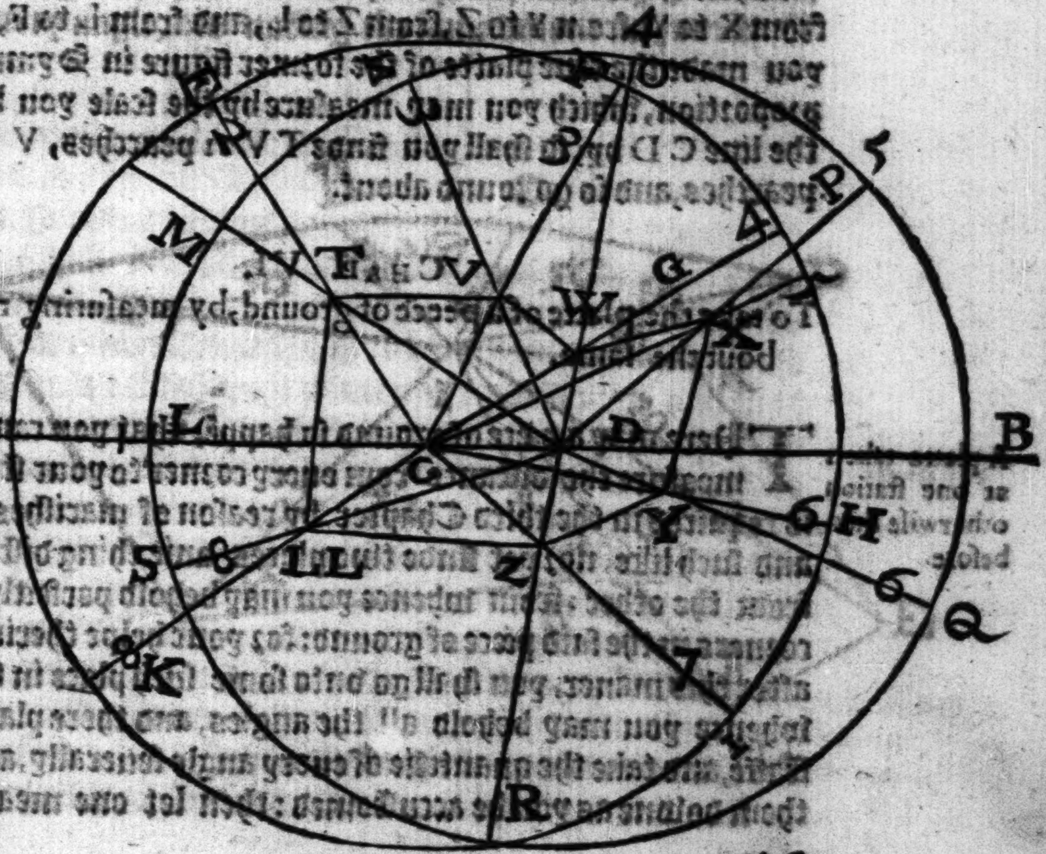
A Table of my ſecond ſtations

The	Degrees
1	33
2	35
3	30
4	38
5	69
6	47
7	58
8 angle	

Totall	Proſe.
360	Chap. 4.

Then with theſe Tables I reſort to ſome plaine and ſmooth ſuperficies, as paper or ſuch like, whereupon I protract all the former angles in maner as is ſaid before.

Example.



Firſt I draw the line A B at all aduentures, then towards the end A, make a point for your firſt ſtation C, whereon deſcribe a circle A E G h K: then protract the angles of the firſt table therein beginning at A, as A C E, E C F, F C G, G C H, H C I, I C K, and K C A, and draw lines from euery of theſe letters to C, as from E to C, from F to C, &c. and put the figures thereunto, for to note the firſt, ſecond, third, &c. angle as you ſée: then from C rightwards in the line A B, ſet out ẏ length of your ſtationary line 15 pearches, as C D, and vpon D deſcribe another circle, L O Q R, and beginning at L, protract ẏ angles of the ſecond table, as L D M, M D N, N D O, O D P, P D Q, Q D R, R D S, and S D L, and then draw lines from each letter to D, as M D, N D, O D, P D, &c. then put figures thereunto as before, to giue thée notice which was ẏ firſt, 2, 3, 4, &c. Now note the concourſe of the ſemblable lines, that is to ſay, where the ſecond line E iſſuing from C, doth méete with ẏ ſecond line M, iſſuing from D, and thus I procéede to all the reſt, ſtill noting the concourſe of the correſpondent lines, which I note with theſe letters, T, V, W, X, Y, Z, L, as in the figure you may ſée.

Then draw lines from T to V, from V to W, from W to X, from X to Y, from Y to Z, from Z to L, and from L to F, ſo haue you made the true platte of the former figure in Symmetrie & proportion, which you may meaſure by the ſcale you laid out the line C D by, ſo ſhall you finde T V 21 pearches, V W nine pearches, and ſo go round about.

Chap. VI.

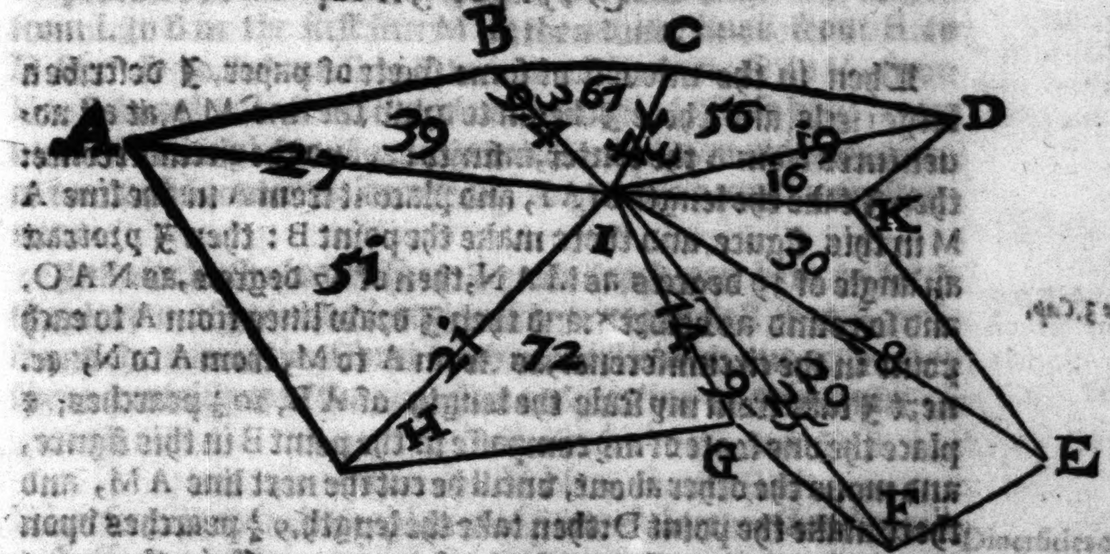
To take the platte of a peece of ground, by meaſuring round about the ſame.

A platte taken at one ſtation otherwiſe then before.

There may a péece of ground ſo happē, that you can neither meaſure the diſtance from euery corner to your ſtaffe, as is required in the third Chapter, by reaſon of mariſhes, fennes and ſuch like, nor yet finde two places anie thing diſtant one from the other: from whence you may behold perfectly all the corners in the ſaid péece of ground: for your helpe therin, worke after this maner, you ſhall go vnto ſome ſuch place in the field, whence you may behold all the angles, and there plant your ſtaffe, and take the quantitie of euery angle ſeuerally, and note them downe as you be accuſtomed: then let one meaſure the length of everie line which doe ſubtend thoſe angles, that is, let every hedge particularly be meaſured, that is included betwixt each corner in the field, which note downe againſt his proper angle; this done, meaſure the diſtance of the firſt corner from your ſtaffe, which alſo ſet downe: theſe things had, protract the foreſaid angles upon a faire borde or cleane ſheete of paper; then on the line which points unto yͤ firſt angle, which you meaſured and noted downe before, lay downe with your ſcale and compaſſe, the length thereof: then take from your ſcale the length of the firſt line which you meaſured on the outer ſide the file, and put the one foote in the point made in the former line, and turne the other about, untill he interſect with the ſecond line; then take the length of the ſecond line meaſured, and doe ſo to the third line protracted, and ſo go round about, as will better appeare in the enſample.

Example.

Suppoſe A B C D E F G H, a piece of ground to be meaſured, I place my ſtaffe at I, and there begin and take the angle A I B, 39 degrées, then B G C, 67 degrées; and ſo I go round, taking every angle, and noting the ſame downe as you ſée.



The quantitie of each angle of ſtation.

1	39
2	67
3	56
4	16
5	30
6	20
7	9
8	27
9	51

Totall } Proofe.
360 } Cap.4.

Then I meaſure the diſtance of A, the angle, from my ſtaffe I, viz. 27 pearches: then I meaſure the length of A B, B C, C D, D E, E F, F G, G H, and H A; which is found, as in the Table.

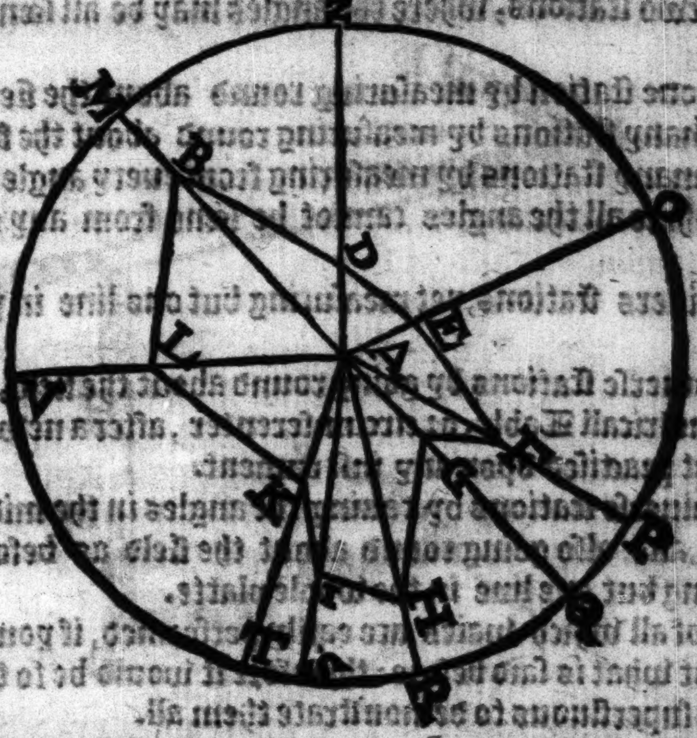
The quantitie of each angle of ſtation, with ſides ſubtending the ſaid angles.

	Ang.	Sides.	
1	39	20¼	A B
2	67	9¾	B C
3	56	16	C D
4	16	7½	D K
5	36	18½	K E
6	20	10¼	E F
7	9	11	F G
8	27	22	G H
9	51	21	H A

A, I, 27 pearches.

Then in the middeſt of ſome ſheete of paper, I deſcribe a large circle, and there I begin to draw the line M A, at all aduentures from A the center, infinite beyond the circumference: then I take the length of A I, and place it from A in the line A M in this figure, and there make the point B: then I protract an angle of 39 degrees, as M A N, then of 67 degrees, as N A O, and ſo round as before*: and then I draw lines from A to each point in the circumference, as from A to M, from A to N, &c. next I take from my ſcale the length of A B, 20¼ pearches, & place the one foote of my compaſſe in the point B in this figure, and moue the other about, vntill he cut the next line A M, and there make the point D: then take the length, 9¾ pearches vpon your ſcale, placing the one foote of your compaſſe in the point D, with the other ſtrike an arch or portion of a circle, & where it interſects with the line A O, make the point E: next take ÿ length

*vide 3.Cap.



length of 16 pearches, placing the one foote of your compaſſe E, and with the other ſtrike ſome ſmall portion of a circle, & where it cuts the line A P, make the point F: doe ſo with all the reſt, as with 7½, from F to G in the line A G, with 18½ pearches, from G to H in the line R A, with 10¼ pearches, from H to I in the line A S, with 11 pearches, from I to K, in the line A T, with 22 pearches, from K to L, in the line A V, and with 21 pearches from L to B in the firſt line M A: then draw lines from B to D, from D to E, from E to F, from F to G, from G to H, from H to I, from I to K, from K to L, and from L to B: ſo haue you made the true platte of your ground, which you may meaſure or know the contents, according as you bee hereafter inſtructed.

Infinite be the waies that I could teach you here to fetch the plattes of ground: but I will here ceaſſe, leſt that I confound the memorie of ſome with multiplicities, and only giue them a catalogue of the diuerſities of platting by this ſtaffe.

Chap. VIII.

Diuerſe waies of taking plattes of ground, by this Geodeticall ſtaffe.

Diuerſities of platting. *vide cap, 3.*

1 At one ſtation, where all the angles in the field may be ſéene, as before.

2 At

Cap.5. 2 At two ſtations, where the angles may be all ſéene, as before.

Cap, 6, 3 At one ſtation by meaſuring round about the field.

4 At many ſtations by meaſuring round about the field.

5 At many ſtations by meaſuring from euery angle to your ſtaffe, where all the angles cannot be ſéene from any one ſtation.

6 At diuers ſtations, yet meaſuring but one line in ỹ whole field.

7 At diuerſe ſtations by going round about the field, as with the geometricall Table, or circumferenter, after a new maner neuer yet practiſed vpon any inſtrument.

8 At diuerſe ſtations by taking the angles in the middeſt of the field, and alſo going round about the field as before, yet meaſuring but one line in the whole platte.

Any of all which waies are eaſily performed, if you vnderſtand but what is ſaid before: therefore it would be to too tedious and ſuperfluous to demonſtrate them all.

CHAP. VIII.

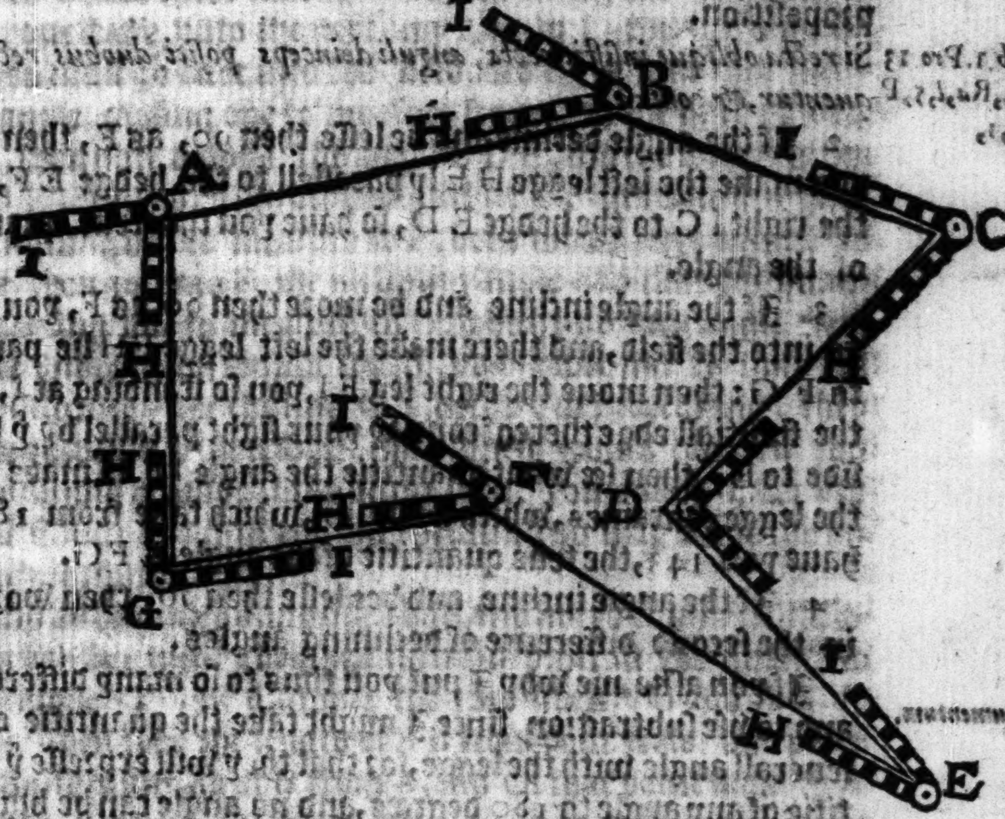
To meaſure wood-land ground, or ſuch other rough grounds, where you cannot run vp and downe with your chaine within, by reaſon of buſhes, or cannot ſee the corners becauſe of Trees.

To meaſure wood-land. Conferre this Chapter with the end of the 48,

I Had well neare forgotten to ſet downe this Chapter, which is more requiſite then the former, for becauſe it often commeth to paſſe, that you be put to meaſure woods and ſuch like, whoſe platte muſt be fetcht by going round about the ſame, becauſe through the impediment of trees and ſuch like you cannot make obſeruations as before, and here I muſt ſhew you to worke after ſuch a way as hath not béene yet publiſhed, in the Theodelitus circumferẽtor, and all other inſtruments, you are now onely guided by the néedle and backe ſite; but here we will hold the néedle as néedleſſe, and to no purpoſe: let there be a péece of ground full of wood, aſſigned to be meaſured, as A B C D E, &c. here you ſée by reaſon of woods and ſuch like, I cannot worke according vnto any of the former Chapters.

In the taking of this platte for your more eaſe in working, you be to conſider 4 things, that is, whether the angle propoſed doe incline into the field, as D, or F, or decline from ỹ field, as A, B, or C, &c. then whether he be more then 90 degrées, or leſſe: this conſidered, you ſhall take their quantitie thus.

1 If



1. If the angle be more then 90 degrees, as B, and decline, the place the left legge B H, to lie parallell to the ſide of the hedge A B, and moue the right legge I, vntill the fiduciall edge thereof direct your ſight to C: then take the quantitie of the angle as the legges be opened vnto, which let be 35, I B H. But you will aske me how I will come by the angle A B C, which is all our drift in this place? you ſhall double the angle I B H made vpon the legges, which was 35, which being doubled there is 70: take that from 360, there remaineth 290: halfe that is the quantitie of the angle required, viz. 145: ÿ reaſon of this worke is grounded vpon this propoſition.

Si duæ rectæ interſecantur, æquant angulos verticales inter ſe, & omnes quatuor rectis. Eu. lib. 1. Pro. 15 Ra, l, 5, P. 8, co, 2

But forasmuch as I B H and his verticall angle are knowne to be equall, and A B C and his verticall angle alſo knowne to be equall; therefore you ſhall not neede to double them, and ſo make ſubtraction, but onely take the angle found vpon your ſtaffe, viz. 35, from 180: ſo haue you 145, as before, which is ÿ true quantitie of A B C, and this worke is grounded vpon this propoſition.

Eu. lib. 1. Pro. 13 & 14, Ra. l. 5. P 8. con. 1.

Si recta oblique inſiſtit rectæ, anguli deinceps poſiti duobus rectis æquentur, & contra.

2 If the angle decline and be leſſe then 90, as E, then ſhall you make the left legge H E ly parallell to the hedge E F, and the right I C to the hedge E D, ſo haue you the true quantitie of the angle.

3 If the angle incline and be more then 90, as F, you muſt go into the field, and there make the left legge E H lie parallell to F G: then moue the right leg E I, you ſo ſtanding at I, vntil the fiduciall edge thereof conuey your ſight parallel by ý hedge ſide to E; then ſee what quantitie the angle I F H made vpon the legge containes, which [illegible] F H, which take from 180, ſo haue you 143, the true quantitie of the angle E F G.

4 If the angle incline, and bee leſſe then 90, then worke as in the ſecond difference of declining angles.

Argumentum.

If you aſke me why I put you thus to ſo many differences, and to vſe ſubtraction, ſince I might take the quantitie of each ſeuerall angle with the legge, for that they will expreſſe ý quantitie of any angle to 180 degrees, and no angle can be bigger. I ſay that is true: yet my reaſon is two fold, firſt in reſpect of the ſmallneſſe of the degrees beyond 140 degrees; ſecondly, & moſt eſpecially, becauſe of the vnaptneſſe of the placing of the legges at ſo great an angle, as well in reſpect of your ſtanding, as the due ordering of the legges: as for the purpoſe, you would take the angle G F E, you muſt then thruſt your ſelfe betwixt the inſtrument and the hedge, otherwiſe you could not come vnto the center, and when you were there, the further diſcommoditie you may eaſily perceiue in ſearching the degrees &c. and ſuch like: yet he that liketh this way better then the former, may vſe it at his pleaſure, for it will well ſerue for any angle. You hauing thus learned to take the quantity of the ſeuerall angles, you ſhall fetch the platt thus.

Plant your ſtaffe at any angle, as at A, and take that angle, then let one with a chaine meaſure ſo farre as your ſight by the fiduciall edge of the right legge paſſed in a right line, as to B, then note the angle G A B, and the line A B downe, then plant your ſtaffe at B, and take that angle, cauſing one to meaſure from that angle you be at, vnto the next, viz. C, then note the angle A B C, and the line B C downe, next remoue your ſtaffe to C, and there take that angle, cauſing one to meaſure from your ſtaffe, unto the next angle, as to D, then go unto D, but you muſt go over into the field, and there take that inclining angle, cauſing one to meaſure from D to the next corner, as E, then note downe the angle C D E, and the length of the line D E, then go to the declining angle E, and take his quantitie, cauſing one to meaſure to F, both which note downe as before: then go unto F, the inclining angle and take his quantitie, cauſing one to meaſure to G: which line and angle note downe: now if you worke truely, you neede not to take the angle G, or meaſure the line G A, becauſe in protracting they will be expreſſed of neceſſitie, therefore I would counſell you for the ſaving of labour ſo to begin, that you might have the largeſt ſide or hedge to doe laſt, becauſe you may avoid the labour of meaſuring him.

Of errours before practiſed, reformed.

Now all the angles and ſides had, and noted downe in a table, as you were taught, beginne then and plott as the quantitie of the angle G A B, drawing the two ſides A G and A B at length: then take the length of A B from your ſcale, and place it in the ſaid line, as at B from A, and on that point making A B one ſide, protract the angle A B C, and ſo go round as your table directs you: and when you come to plott at the angle F, you ſhall ſee that you neede not to meaſure the line G A, or take the angle G, becauſe the interſection of A G and F G giveth the line A G, and the angle G: nay that which is more, you need not meaſure the line F G, but onely take the angle G F E, for that the interſection of the ſide F G and A G, will give the length of theſe two lines, as it doth the quantitie of the angle G, let this enſuing rule therefore be inſerted to this kinde of meaſuring generall.

If the figure or place propoſed to be meaſured, be a triangle of what ſides ſoever, as an Iſopleuron, Iſoſceles or Scalenum, or of what angles ſoever, as an orthogonium, [illegible] or oxigonium, you ſhall meaſure but one ſide and two angles: in quadrangles of what kinde ſoever, as right angled parallelograms and oblonges, or oblique angled parallelograms as Rhombes and Romboides: meaſure but 2 lines and 3 angles: and [illegible] of a Trapezia, which is quadrangulate, but more [illegible] it thus.

In all figures, be they multangles or otherwiſe, you may omitte the meaſuring of any one angle and his two ſides [illegible]

Chap. IX.

Of errours daily practiſed in platting ground, and of the reformation thereof.

Of errours before practiſed, reformed.

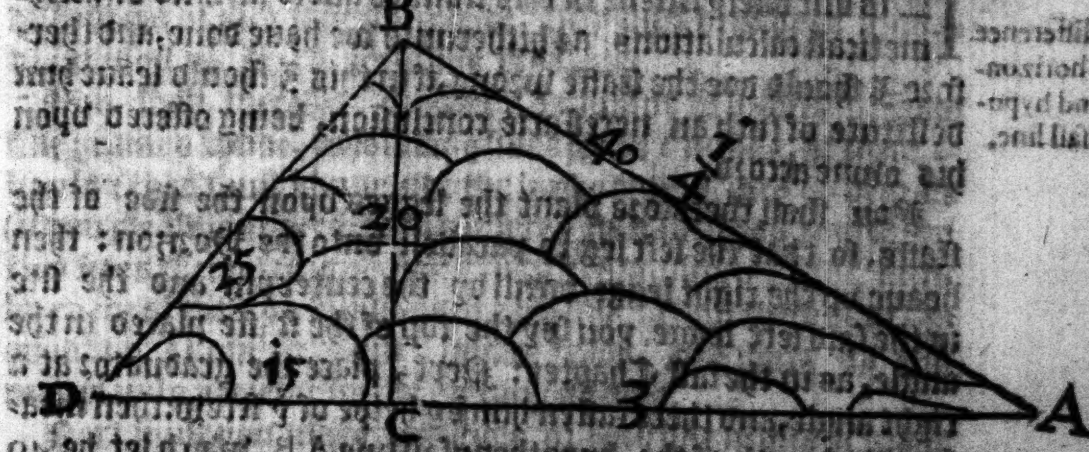
In taking and platting of vneuen grounds, our land-meaſurers continually practiſe and commit great errours, becauſe when they are put to meaſure a hill, or an aſcending ground, when they go round about the ſaid field, as is ſaid before, and ſo meaſure from corner to corner, I ſay, the ground lines they meaſure with their chaine, be hypothenuſall, and the right lines they protract be horizontall: ſo that it is not poſſible that their platte ſhould cloſe. I haue ſeene diuerſe vſing the Geometricall Table, called of ſome the plaine Table, impute the not cloſing of their platte to the ill ordering of the needle & the backe ſight, when it was nothing elſe, but the want of ſkill to reduce yͤ Hypothenuſall lines vnto lines Horizontall, though indeed there may be great errors vnawares committed by meanes of the needle and backe ſight: but to returne vnto our purpoſe, the onely meanes to helpe theſe forepractiſed errours, is to reduce the lines hypothenuſall vnto lines Horizontall.

Eu, lib, 1, P, 18 & 19.
Ra, lib, 6, p, 11
Lu, lib, 1, p, 47 & 48,
R, Lib, 12, P, 5

It is certaine that in this kinde of working, the hypothenuſall line A B, is a line ſubtending a right angle, and therefore is the longeſt line that may be made in any orthogonium, as may be proued *: for that a right angle is the greateſt angle that can be made in any orthogonium triangle: this granted, then of conſequence muſt the line A C called here the horizontal line being the baſe of the ſaid triangle, needes be leſſe than the line C B: for that the hypothenuſall C B, is in power equall to the horizontall A C, and the perpendicular B C *, and ſo of neceſſitie more then the line A C, be the perpendicular or Cathetum B C neuer ſo ſhort: then let them confeſſe how farre they haue erred heretofore, which haue laid downe the hypothenuſall line in ſtead of the horizontall, ſince here it is apparant that if they meaſure aſcending or deſcending grounds, it is not poſſible for them to make their platte cloſe, vnleſſe the lines hypothenuſall be reduced into lines horizontal: ſo then it reſteth for vs, hauing the length of the line A B giuen, by meaſure or otherwiſe, to finde the length of the line A C, and him protract vpon our paper, which is thus performed.

Let there be a marke placed before you in the angle, whereunto you would direct your ſight, iuſt ſo high from the ground as your eie is placed, viz. 4 foote: now are you to conſider if the ground aſcend, as A B, or deſcend, as B E.

If the ground aſcend, as A B, open the legges of your inſtrument unto a right angle, turning the right legge towards the marke, and cauſing the left legge to lie parallell: then bring the center of the graduator unto any number of diuiſions where you will, as to 30, heauing vp the other end, untill the frontiall edge thereof conuey your ſight direct unto the toppe of ẏ ſtaffe before planted in the angle at B: then ſhall you note the equal parts cut by the right legge vpon the graduator, which let bee 34 and better: laſtly meaſure the hypothenuſall line A B, which let be 40 ½ pearches: then multiply the equall parts cut by the center of the graduator vpon the left legge, viz. 30 in 40 ½, the length of A B: and the product deuide by the parts cut vpon the graduator by the right legge, viz. 34, and better: ſo haue you 35 the length of the line A C, whereby you may inferre that ẏ line A B, which was meaſured 40 pearches, muſt bee laid downe in protraction: but 35 pearches & this propoſition may you worke by the 5 Booke, Cap. 2.



Here note if the ground both aſcend & deſcend, as A B and B D, you need but take the angle D B A, then meaſuring the two ſides containing the angle, viz. A B, & D B then worke as in the 2. Booke, Chap. 20. imagining D A a diſtance, or Booke 7, cap. 3. Axioma 4, de. 2

This Propoſition may alſo be wrought Symmetrically by the table of Sines: for if you take the angle A, which here is 30 from 90, ſo haue you 60 the angle C B A, as may be proued,* becauſe one of the angles is knowne to be right: hauing the angles, then finde the Synes, and proportion them accordingly.

And as you worked for grounds that did aſcend, ſo muſt you worke for grounds that doe deſcend: onely it were beſt that the left legge ſhould ſtand perpendicular, and the right parallel, which before was placed perpendicular.

Vide lib. 7. axiom 3. ſub. 3.

*Eu. lib. 1. P. 32. Ra. lib. 5. 20 9

But foraſmuch as ſome will hold this way tedious to ſtand calculating in the field, and for that Arithmeticke is not common vnto euery one, nor the briefe vſe thereof knowne vnto all men, you ſhall haue a way enſuing to auoid all arithmeticall calculations.

Chap. X.

To finde the difference betwixt the hypothenuſall and the horizontall lines without calculation.

The difference of the horizontall and hypothenuſall line.

IT is our onely intent in this ſtaffe to auoid all kind of arithmeticall calculations, as hitherunto we haue done, and therfore I ſhould doe the ſtaffe wrong, if in this I ſhould leaue him deſtitute of ſuch an neceſſarie concluſion, being offered vpon his owne accord.

You ſhall therefore plant the legges vpon the ſide of the ſtaffe, ſo that the left leg ly parallell vnto the Horizon: then heaue vp the right legge, vntill by the center pin and the ſite in the ſaid left legge, you ſpy the top of the ſtaffe placed in the angle, as in the laſt Chapter: Next, place the graduator at a right angle, and there faſten him by helpe of yͤ ſcrew: then meaſure the length of the hypothenuſall line A B, which let be 40 pearches, and count that vpon the right legge making a marke there: next ſhall you draw the center of the graduator along yͤ left legge, not altering him from his right angle, vntill the fiduciall edge thereof iuſt cut the point before noted, at 40 in the right legge: the equall parts then vpon the left legge, included betwixt the center of the graduator, and the center of the inſtrument, is the length of the ſaid horizontall line, which you ſhall finde to be 35 pearches as in the laſt Chapter.

If the ground deſcend, as B D, then muſt you make the left legge hang perpendicular, pointing towards the ground, and the graduator to lie parallell at right angles, with the ſaid left legge.

And here let it be noted, that your beſt way is onely in the field to take the angles of altitude, and meaſure the hypothenuſall line, noting whether the line did aſcend, or deſcend: and then may you reduce the ſame at home when you protract, as is taught.

CHAP. XI.

Of the making of a new quadrant to be vſed with the geodeticall ſtaffe, for the finding out of the horizontall lines in the platting of grounds.

Some it may be will ſeeme curious, that they will hold it much labour to take off the legges from the toppe of the ſtaffe, and place them vpon the ſide when they meaſure vneuen grounds, which I am perſwaded can be no labour at all: howbeit, becauſe I would ſet my ſtaffe ſo neare as I might vnto the diſpoſition of each ſeuerall minde, they ſhall here haue a quadrant moſt apt for to performe the ſame.

A new Quadrant to finde the horizontall and hypothenuſall lines.

You ſhall therefore prepare a quadrant of braſſe, or ſome fine grained woode, whoſe two ſides let be 6 inches, or there abouts: then muſt you deuide the limbe thereof into 90 degrees (if you pleaſe) as the common order is: then ſhall you deuide the two ſides thereof in 90 equall parts, drawing parallell lines by euery of thoſe 90 diuiſions in each ſide, ſo will there be in the quadrant a number of ſmall ſquare holes, according as you may plainly perceiue by the enſuing figures.

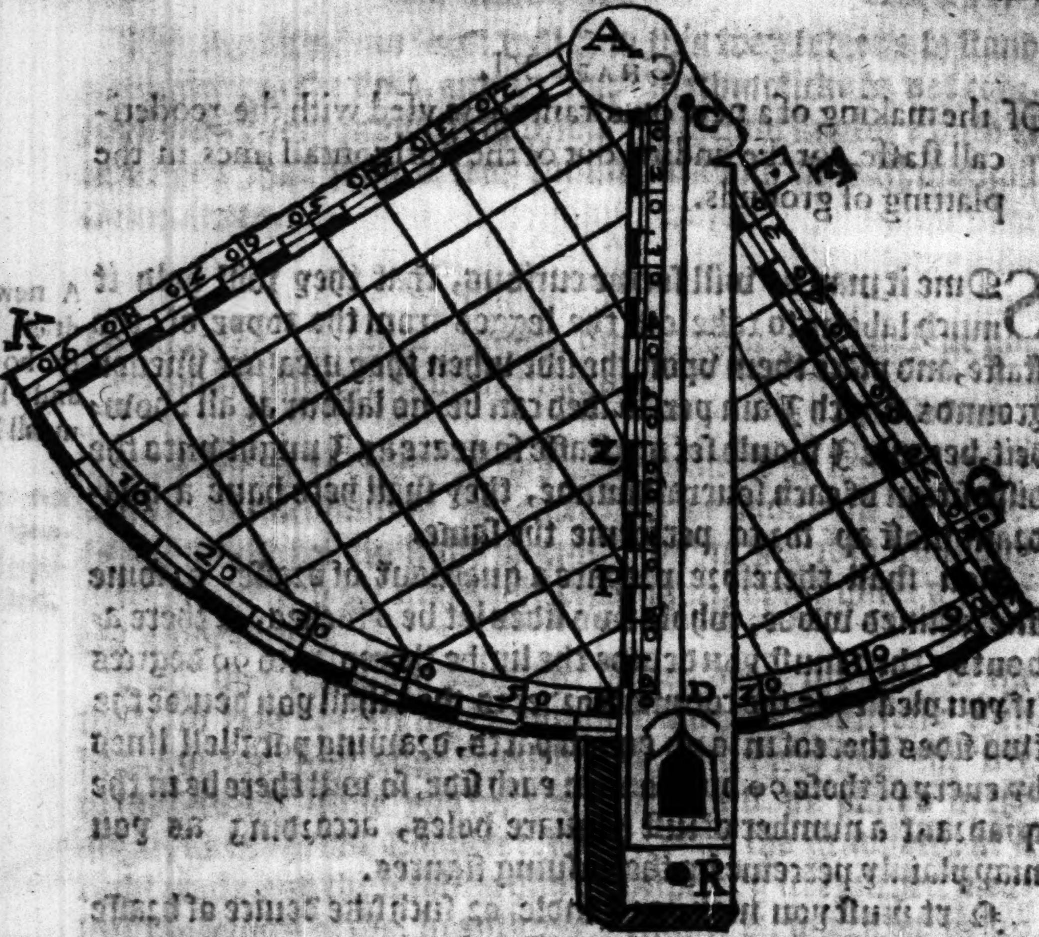
Next muſt you make an handle or ſuch like deuice of braſſe or wood, with a ſlit through the ſame for the quadrant to moue in: the center of which quadrant muſt be placed in the toppe of the handle, according as you ſee at A, and then muſt there be a ſtraight line for to anſwere vnto the center of the quadrant, as A B, which muſt be deuided into 90 ſuch equall parts as the one of the ſides of the quadrant was: vpon this handle there muſt be ſtruck a line C D, parallell to the edge A B, whereon muſt hang a line with a plumb: laſtly in the foote of this handle there muſt be a hole, as at R, through which muſt go a ſcrue pin of braſſe into the hole in the ſide of the ſtaffe, to the end ẏ by the helpe thereof, you may faſten the handle firme vpon the ſide of the ſtaffe, as occaſion requireth, all which you may plainly perceiue in viewing well the enſuing figure.

The quadrant thus ordered, you ſhall fall to worke therewith in this maner.

To worke by the new quadrant.

Place the hole R vpon the ſide of your ſtaffe, by helpe of a ſcrew pin, cauſing the handle D C to ſtand perpendicular by

help



help of the plumb: then hauing prepared your ſtaffe to be caried before you, as it is ſaid before, and duely placed in the angle, heaue vp or put downe the ſide of the quadrant, vntill through the two ſights F and G, you ſee the top of the ſtaffe before planted in the angle: then count the hypothenuſall line vpon the handle A B, towards B: the line which then paſſeth by that number vnto the ſide A K, is he that limits the length of the horizontall line, which you muſt protract, being numbred in the ſide A K.

As for the purpoſe, let the quadrant ſtand as he doth: I count the line meaſured beeing 55 pearches vpon the handle from A towards B, and there doe I ſee a line paſſe by at Z, which following to the ſide A K, I finde him numbred, 30: whereby I may conclude that the line meaſured 55 pearches, muſt in protraction be laid downe but 30 pearches, and ſo of any other. Or you may take the angles of aſcenſion in the field, and meaſure the hypothenuſall line, and then reduce them by the quadrant when you come home, onely noting in the field the angle of aſcenſion, and the length of the hypothenuſall line: for which purpoſe I haue appointed the limbe of the quadrant to be deuided into 90 degrées, as the common order is, and ſo worke in angles of deſcenſion.

Chap. XII.

To take an altitude onely by the Quadrant.

HAuing placed the handle to ſtand perpendicular as before, heaue vp or put downe the ſides of the ſaid quadrant, vntill through the ſights F G, you ſée the ſummite of the altitude: the quadrant ſo reſting, count the diſtance of the Towre from you in the ſide A K, and where that number ends, note there what line paſſeth thence vnto the handle: for the line croſſing there, and paſſing to the ſide F G, limits the deſired altitude.

Altitudes by the new quadrant.

Example.

Let the Quadrant reſt at the angle he doth, and let the diſtance of the Towre from you be 40 féete: I count 40 vpon the ſide A K, and there doe I ſée a line paſſe thence to the handle interſecting at P, whence doe I ſée a croſſe line paſſe to the ſide F G, which is numbred 60: and ſo many féete high may I conclude the Towre to be: then ſhall I ſée 70 féete counted vpon the handle from A to the interſection of the foreſaid lines at P, which is the length of a ſcaling ladder, and ſo of any other.

So may you finde out depths: many rare concluſions might be performed by this quadrant, which at this time for want of opportunitie I am forced to omit.

So then by that which is ſaid before, you may be anſwered, that it is not poſſible for any man vpon one ſcale to lay downe the true platte, and by the ſame ſcale expreſſe the true contents of aſcending or deſcending grounds: for becauſe if he make the platte true, and then by the ſame ſcale caſt vp the cōtents thereof, it will be leſſe then the ground it ſelfe is: and againe if you lay down the true contents of ſuch vneuen grounds, then the map you make will neuer cloſe, nor you be able to ſet forth the true proportion and Symmetry of the ſaid grounds.

The beſt way therefore is, for him that will meaſure vneuen grounds, to prouide two ſcales, one to expreſſe the true hypothenuſall line, and the other to lay downe the true horizontall line: and ſo by taking notice thereof, you may worke with more truth then I haue ſeene any hitherto practiſe.

CHAP. XIII.

The legges being opened vnto any angle, to finde the quantitie thereof without the helpe of the graduator in a moſt excellent maner, ſo that you may take expreſly the quantitie of any angle, and put aſide the graduator or protractor.

To finde the quantitie of any angle vpon the legges without the graduator.

YOu muſt turne the backe ſide of the legges vpwards, and then with a paire of compaſſes take the diſtance ouer from one legge vnto the other, in the two points reſpectiue: the compaſſe reſting at that extent, apply the one foote to the center of the inſtrument, and turne the other towards the point reſpectiue in one of the legs, and where that foote of the compaſſe falleth amongſt the diuiſions, the degrée there ſet, is the quantitie of the angle: but if the angle excéede 90, then hauing taken the diſtance ouer betwixt the two points reſpectiue, halfe that diſtance, and apply it vnto the legs, as before, ſo ſhall you finde halfe the quantitie of the angle, which double, ſo haue you the whole: and by this meanes may you take the height and diſtance of ſtarres, meaſure grounds, &c. without the helps of the graduator.

As for to make proofe of this Chapter by helpe of the graduator, open the legges vnto an angle of 30 degrées, then with your compaſſe take the diſtance ouer in each legge betwixt the points reſpectiue: which applying to one of the legs, as before, you ſhall finde the foote of your compaſſe fall iuſt in 30 degrées, which is the angle the legges then make, allowing ſome ſmall difference for the ſloping of the chard diuiſions from the frontiall edge of each legge.

To open the legges vnto any angle aſſigned.

To open the legges vnto any angle aſſigned.

Place the one foote of your compaſſe in the center of the legge, and extend the other vnto the angle required, in one of the legges amongſt the deuiſions vpon the lower ſide: which wideneſſe of your compaſſe ſtill remaining, ſet the ſame ouer in the two points reſpectiue, opening the legges vntill 60 degrées, or each point reſpectiue agrée with the ſaid wideneſſe of the foote of your compaſſe, and ſo is the angle made: and ſo muſt you worke in any other ſuch demand: this propoſition is moſt excellent for to finde angles in the 2 Booke, Cap. 29, &c. whereby you may performe it with great eaſe and ſpéede.

CHAP. XIIII.

Hauing taken the quantitie of each angle, and meaſured the lines truely, in going round about wood grounds, as Lordſhips or ſuch like, to know if you haue wrought truly or not.

To know if you haue wrought truely or not.

HAuing gone round about the wood or Lordſhip propoſed to be meaſured, adde all the quantities of each ſeuerall angle together, and note the totall: then multiply 180 by a number, which ſhall be leſſe by 2, then the number of angles or corners in the ſaid field, and note the product; for if it agree with the former totall, you haue wrought truely, otherwiſe not, and your platte ſhall not cloſe.

Example.

The totall of all the angles being added together, is 540, ẏ number of angles is 5, from which I take 2, the remainder is 3: 180 multiplied by 3, produceth 540, agreeing with the former totall: which argues my platte will cloſe, & that I haue wrought truely, and ſo of any other.

The geometricall ground hereof is grounded vpon theſe Propoſitions enſuing.

1 *In omni triangulo tres anguli ſimul ſumpti, ſunt duobus rectis æquales. Euc. lib. 1. P. 32. Ram. lib. 6. P. 9.*

The 3 angles in any tryangle are equall vnto two right angles, therefore 180 is multiplied.

2 *Cuiuſcunque triangulati latera ſunt binario plura triangulis, è quibus conſtat. Ram. lib. 10. Pro. 1. conſ. 1.*

The ſides of a tryãgulate are more by 2, then the tryangles whereof he is made.

Therefore multiply by two leſſe then the number of ſides or angles, in the multangled figure.

The end of the firſt part of the art of Geodetia.

THE SECOND PART OF

Geodetia, containing the meaſuring of the ſuperficiall content or *Area* of any platte, peece of ground, *mappe or ſuch like, howſoeuer formed: and that two kinde of* waies, as Arithmeticall, or vulgarly without calculation, with diuerſe new tables, as well for the caſting vp or deuiding of grounds, as alſo to extract the ſquare roote, or finde the true ſquare of any number, with the meaſuring of all kinde of ſuperficies, as boords, glaſſe, &c. or ſolids, as tymber, ſtone, &c. after diuerſe waies, both old & new, together with the ground of the worke: alſo to ſeeke dimenſions of heights, bredths, &c. by protracting after my new kinde of working, to ſeparate or incloſe grounds, or make any figure according vnto any proportion aſſigned onely by the ſtaffe, to metamorphize or transforme any figure from one ſhape vnto any other, for the more ſpeede in meaſuring to finde what proportion peeces of ground, glaſſe, boords, or any ſuperficies one hath to the other: the making of a compendious Table to containe the legall part of meaſuring ground, with many Apophthegmes, requiſite for all Geodetors *to vnderſtand.*

CHAP. XV.

Of ſuch things that are to be conſidered in the caſting vp of grounds, as alſo to extract the ſquare roote, or finde the true ſquare of any number by a Table.

Of things which are to be preconſidered.

I Haue before giuen you rules how to fetch the true platte of grounds out of the field as they lye: it reſteth now to declare by what meanes wee ſhall finde the ſuperficiall content thereof: but before we ſpeake thereof, hauing a platte of a péece of ground giuen, you muſt conſider whether it be a tryangle, a quadrangle or a multanguled figure: and if it be a tryangle, how he is diſtributed, as well in reſpect of his ſides, as in reſpect of his angles: in reſpect of his ſides, whether it be an Iſopleuron, Iſoſceles, or a Scalenon: in reſpect of his angles, whether an Orthogonium, Ambligonium or Oxigonium.

If the platte be a quadrangle or figure of 4 angles, then muſt you conſider whether it be a parallelogram, or a Trapezia: if a parallelogram, whether a quadrāt, an oblonge, or an obliquangle: if obliquangled, whether a Rombus, or a Romboides.

If your platte be a figure multangled, then muſt he be reduced into ſome regular figure, and ſo meaſured as hereafter, and you ſhall note that it is beſt to reduce any multangled figure into tryangles, becauſe they be ſooneſt done, and eaſieſt meaſured: but firſt behold briefly what is ſaid before, for

Ignorant in the termes, and ignorant alſo in the Art.

Geometriæ Radix.

- Geometry is diſtributed into 2 parts, whereof the firſt delivereth:
  - Things given, that is, the definitions of magnitudes & their ſpecies, as well
    - Lineall, which is either
      - Right, vide B
      - or obliques B
        - Simple, vide C
        - or mixt D
    - as E Lineamentall being
      - F An angle, which is
        - G Homogeneall, being
          - Right, vide H
          - or I oblique which are
            - K Acute
            - or L Obtuſe
        - or Hetrogeneall.
      - or a figure, vide M
  - Things required, that is, the adiunct or habitudes of given magnitudes.

A Table to finde any of the preſcript in *Euclide* or *Ramus* their Geometry, *according as you be Alphabetically directed.*

Let.	A	B	C	D	E	F	G	H	I	K	L
Eu.	l.1.d.4.									l.1.d.12	l.1.d.11
Ra.	l.2.p.5.	l.2.p.6	l.2.p.8	l.2.p.9	l.3.p.1.	l.3.p.3	l.3.p.4.	l.3.p.8	l.3.p.9	l.3.p.11	l.3.p.10
Let.	m.										
Ra.	l.4.p.1.										

The kinds of Figures, are

- Superficies, which be
  - Plaine being
    - Right lined which are
      - Triangles consisting of
        - Angles
          - Right Chap. 16.
          - or oblique being
            - Acute, cap. 17, 18, & 19
            - or Obtuse, cap. 20, Pro. 2, & 3
        - or sides being
          - Equall: as an Isopleuron, cap. 17
          - or unequall, as an
            - Isosceles, cap. 18
            - or Scalenum, cap. 19
      - or Multangulares being
        - a quadrangle, which is
          - a parallelogramum being
            - Right angled which be
              - quadrants, ca. 22, P. 1.
              - or Oblongs, cap. 22, P. 2.
            - or oblique angled as a
              - Rombus cap. 22 P. 3.
              - or Romboides ca. 22. P. 4
          - or a Trapezia. Cap. 22 Pro. 5.
        - or a multangle, ca. 23
    - or circular
      - Simple, as a circle cap. 23 & 24
      - or Mixt, consisting
        - of two termes
        - of many termes
  - or Swelling.
- or Bodies cap. 25.

To

To extract the Quadrant roote, or to finde the ſquare of any number with great ſpeede, by helpe *of a new Table.*

IF you ſeeke the quadrate roote of any number, enter the table following, ſeeking the ſaid number whoſe radix is deſired, in one of the colums deſcending, vnder the Title of ſquare nūbers: the which if you finde preciſely written there then the number anſwering in order on the left hand, vnder the title of Radix, is the iuſt ſquare roote of the number propoſed: as if you would ſeeke the ſquare roote of 1600, enter the Table following, ſeeking therein orderly vnder the title of ſquare number, the ſaid number 1600: ſo ſhall you finde in the row on the left hand vnder the title of Radix, 40 anſwering thereunto, which is the ſquare roote of the ſaid number 1600: and ſo contrariwiſe hauing the radix giuen, to finde the ſquare number thereof.

But if the number whoſe ſquare roote you ſeeke be not preciſely to be found in the table, then muſt you worke with a double entring in this maner: take two ſquare numbers expreſſed in the Table, whereof let the one be the next, that is leſſe then the number propoſed, & the other the immediate greater: then take the leſſer of thoſe two out of the greater & that which remaineth call the firſt number, which indeede is the portion or fraction of the integer number, and is called the difference, and ſhall be the deuiſor; afterwards ſubtract the foreſaid leſſer number, out of the number propoſed, whoſe radix you ſeeke, and the reſidue keepe for a ſecond number, then the third number ſhall alwaies be 60: therefore augment the ſecond number reſerued, in the third, and the product deuide by the firſt; and that which ſhall be gathered by this deuiſion, ſhall be added to the ſquare roote of the leſſer of the numbers found in the table: ſo ſhall you haue the true ſquare roote of the number propoſed.

Example.

Let the number propoſed be 829, I cannot finde this number preciſely in the table, wherfore I take in the table that number which is next leſſe then it, which is 784, and the next greater, which is 841: the difference of theſe numbers is 57, as you may perceiue in the rowe on the right hand vnder the title, Difference, and this difference is the firſt number, and the deuiſor: to conclude, the leſſer number being ſubtracted from the number propoſed, viz. 784, from 829, there remaineth 45, that is to ſay, the ſecond number: the third number (as is ſaid) is alwaies 60, therefore augment the ſecond in the third, and there is produced 2700 parts of fractions, which deuide by the firſt number that is 57 parts or fractions, ſo is the quotient 47 ferè, which are fractions to bee added vnto the ſquare roote, that is 28: ſo will there riſe 28 integers, and 47 fractions, the radicall ſquare of the number propoſed, viz. 829.

A perfect Table for the extraction of ſquare rootes, or finding the true ſquare of any number, from 2 to 14290, *faithfully ſupputated.*

Radix.	Square number	Differ.	Radix.	Square number	Differ.	Radix.	Square numbers.	Differ.	Radix.	Square nũbers.	Differ.
2	4	3	32	1024	63	62	3844	123	92	8464	183
3	9	5	33	1086	65	63	3969	125	93	8649	185
4	16	7	34	1156	67	64	4096	127	94	8833	187
5	25	9	35	1225	69	65	4225	129	95	9025	189
6	36	11	36	1296	71	66	4356	131	96	9219	191
7	49	13	37	1369	73	67	4489	133	97	9409	193
8	64	15	38	1444	75	68	4624	135	98	9604	195
9	81	17	39	1521	77	69	4761	137	99	9801	197
10	100	19	40	1600	79	70	4900	139	100	10000	199
11	121	21	41	1681	81	71	5041	141	101	10201	201
12	144	23	42	1764	83	72	5184	143	102	10404	203
13	169	25	43	1849	85	73	5329	145	103	10609	205
14	196	27	44	1936	87	74	5476	147	104	10816	207
15	225	29	45	2025	89	75	5625	149	105	11025	209
16	256	31	46	2116	91	76	5776	151	106	11236	211
17	289	33	47	2209	93	77	5929	153	107	11449	213
18	324	35	48	2304	65	78	6084	155	108	11664	215
19	61	37	49	2401	97	79	6241	157	109	11881	217
20	400	39	50	2500	99	80	6400	159	110	12100	219
21	441	41	51	2601	101	81	6561	161	111	12321	221
22	484	43	52	2704	103	82	6724	163	112	12544	223
23	529	45	53	2809	105	83	6889	165	113	12769	225
24	576	47	54	2916	107	84	7056	167	114	12996	227
25	625	49	55	3025	109	85	7225	169	115	13115	229
26	676	51	56	3136	111	86	7396	171	116	13346	231
27	729	53	57	3249	113	87	7569	173	117	13579	213
28	784	55	58	3364	115	88	7744	175	118	13814	235
29	541	57	59	3481	117	89	7921	177	119	14051	237
30	900	59	60	3600	119	90	8100	179	120	14290	239
31	961	61	61	3721	121	91	8281	181			

Chap.

CHAP. XVI.

Of an Orthogonium, or right angled Tryangles, & to meaſure the area or ſuperficiall content thereof, with the ground and reaſon of the worke.

Of an Orthogonium, Iſoſceles.

Propoſition. 1.

AN Orthogonium Iſoſceles is ſuch a figure, that hath one right angle and two equall * ſides, as B A C, and may be meaſured after two manner of waies, thus.

De Triangulo rectangulo Iſoſceles, Euc. 1. Def. 25.

1 Multiply the one equall ſide in himſelfe, that is, ſquare ẏ one ſide halfe, which is the ſuperficiall content, which is eaſily found by the 27 Chapter.

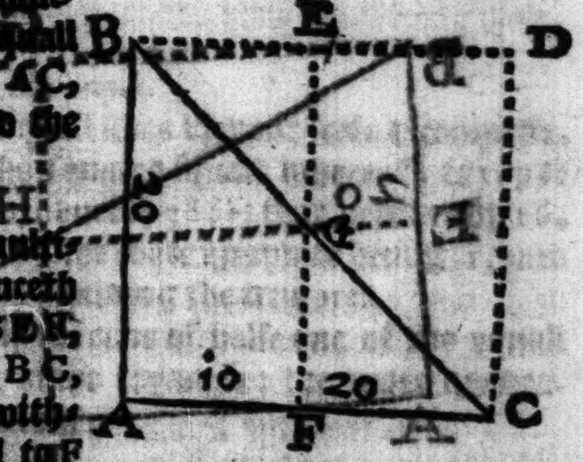
Example.

A C is 20 pearches, the ſquare whereof by the Chapter is 400, the area of A B D C: halfe which is 200, the content of B A C, for A B C is equall to B C D.

2 Or thus, you muſt multiply A C one of the equall ſides in A F the halfe of A C, ſo ſhall the product yeeld the area.

Example.

A F 10 pearches, multiplied in A B 20, produceth 200, the contents of A B E F, which is equall unto A B C, for B E G, the triangle without the figure is equall to F C G, the tryangle within the figure: therefore the one doth decreaſe what the other hath in exceſſe.



Of an orthogonium Scalenum.

Propoſition. 2.

THis figure is ſuch an one that hath but one right angle, as A: * and all his ſides be unequall: and as the meaſuring of ẏ right angled Iſoſceles depended on the meaſuring of a right angled equilater parallelogram, or ſquare, ſo doth this orthogonium Scalenum rely upon an oblonge: for the two ſides

De triangulo rectangulo, Scaleno Euc. l. 1. Def. 26. E. 1. def. 27. Ra. 8. Pro. 2.

containing the right angle, as A B, and A C are but the 2 ſides of an oblonge, as you may perceiue by the pricked lines, & may be meaſured after two maner of waies, thus.

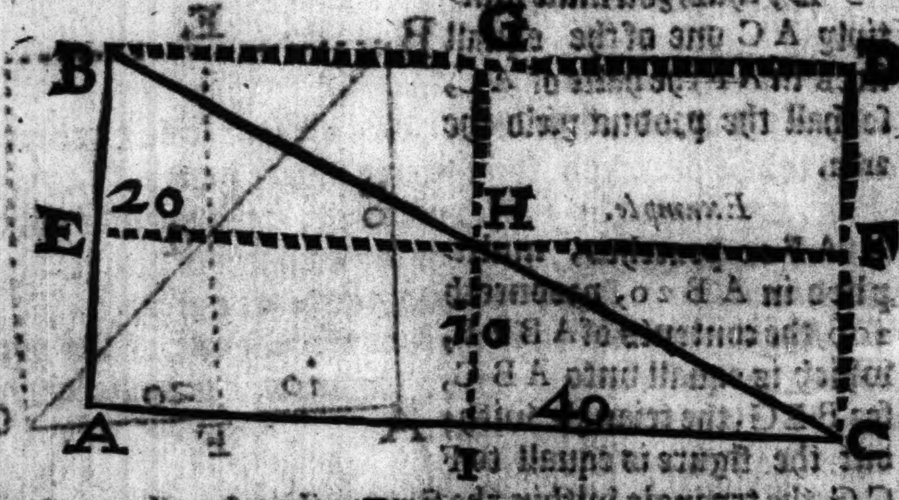
1 Take with your compaſſe the length of two of the ſides containing the right angle, and thẽ multiply one of thoſe ſides in the other halfe the product, whereof is the ſuperficiall content or area of the right angled Scalenum.

Example.

A B is 20 pearches, and A C 40: 20 multiplied in 40, produceth 800, halfe which is 400, the true area of the ſaid peece of ground.

Whereby you ſée that A B augmented in A C, yeelds the content of A B B C, the oblonge: but for that we deſire but ỹ area of A B C, which is but the halfe thereof, therefore I take but halfe of the product, and it ſufficeth.

2 Or you may multiply the one ſide in halfe the other, and the product is the true area.



Example.

As H I, 10, multiplied in A C 400, produceth 400, as before.

Or E H 20, halfe A C multiplied in A B 20, produceth as before.

Wherein you ſée you worke alwaies but as it were an oblonge, or a ſquare, and may eaſily perceiue the ground by applying the pricked lines vnto the preſcript of this propoſition.

And thus farre of right angled Tryangles, called Orthogonium.

Chap.

Chap. XVII.

Of Acute angled Tryangles called Oxigonium.

Of acute angled tryangles, there be three ſorts, and euery one hath his proper meaſuring: the firſt hath all his ſides equall, and is called an orthogonium Iſopleuron: the ſecond an oxigonium Iſoſceles, and the third a Scalenum oxigonium, the difference allwaies riſing in the ſides.

Oxygonia Triangula triplicia.

To meaſure an oxigonium Iſopleuron.

Propoſition. 1.

An Oxigonium Iſopleuron is ſuch a figure whoſe 3 ſides be all equall, and whoſe angles be all acute, and may be meaſured after 4 ſeuerall waies.

De Triangulo oxigonion æquilatero
Euc. 1 Defi. 24.
Ra. 8. Pro 8
Euc. 1. Defi. 29.

Firſt, ſquare the ſquare of one of the ſides by the Chapter: then multiply the off-come in 3, and the product deuide by 16: the roote quadrate is the area: this may depends rather upon proportion, then otherwiſe.

Example.

Admit A B one of the equall ſides by your ſcale & compaſſe, found to be 6 pearches, the ſquared ſquare whereof, is 1296: which augmented by 3, produceth 3888: that deuided by 16, yéeldeth in the quotient 243, the roote quadrate being 15 and better, as betwixt $\frac{1}{2}$, and $\frac{18}{31}$, yéelding the true area.

2 Or you may multiply the cube of halfe one of the equall ſides in the ſemiperimeter of the tryangle: the roote quadrature is the ſuperficiall content.

Example.

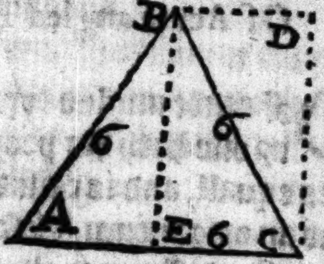
The cube of A E, 3, being halfe A C, is 27, which if you multiply by the Semiperimetry B A E, 9, yeeldeth 243, whoſe roote quadrature is the true contents, as before, viz. 15, &c.

3 Square one of the knowne ſides, which multiply in 13, then the number reſulting, deuide by 30, ſo haue you the contents.

Example.

The ſquare of A B is 36, which multiplied in 13, produceth

468, which devided by 30, leveth 15, &c. as before.



4 But Arithmeticall with moſt eaſe, take it thus. Take the length of the perpendicular let fall from any angle unto his oppoſite ſide ſubtending the ſaid angle, as you bee taught: which multiply in halfe the length of the baſe, the product whereof is the area: for the perpendicular and halfe one of the ſides repreſent the two ſides of an oblonge, equall to the Tryangle. Chap. 21. & 25.

Example.

The perpendicular B E is 5 pearches, and ſomething better, and E C halfe A C, 3 pearches: 3 multiplyed in 5, &c. produceth 15, &c. as before, the area of the oblonge B D C E, which is equall unto the oxygonium Iſopleuron A B C.

CHAP. XVIII.

Of an oxygonium Iſoſceles, and to meaſure the area thereof.

De Triangulo Oxygonio Iſoſceles.

This tryangle is ſuch a figure that hath all his angles acute, as before, only having but two ſides equall, * wherein the difference conſiſteth: and hath two meaſurings proper to himſelfe.

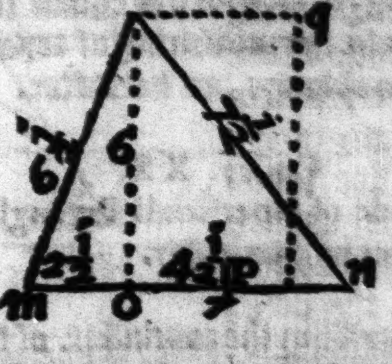
* *Euc. l. 1. Def. 25*

1 Firſt from the ſquare of one of the equall ſides, ſubtract the ſquare of halfe the baſe or ſide which is unequall: the quadrate roote of the remainder multiplyed in halfe the baſe, produceth the ſuperficiall content.

Example.

Let A B one of the equall ſides be 6 pearches, let B C the baſe be 4, the halfe whereof is 2: then take 4 the ſquare of 2, from 36 the ſquare of 6, there reſteth 32: the roote quadrate whereof multiplyed in 2, produceth 11 $\frac{7}{22}$ pearches, the area very neare.

2 Or with more eaſe as before, you may reduce this figure into an oblonge thus: take the length of the perpendicular as you be *taught, and multiply that length in halfe the baſe, and note the product for the true area.



Chap. 11. Pro. 3 & Chap. 15.

Example.

Multiply D C in D A, ſo have you the contents of A E C D the oblonge, which is equall unto A B C the tryangle.

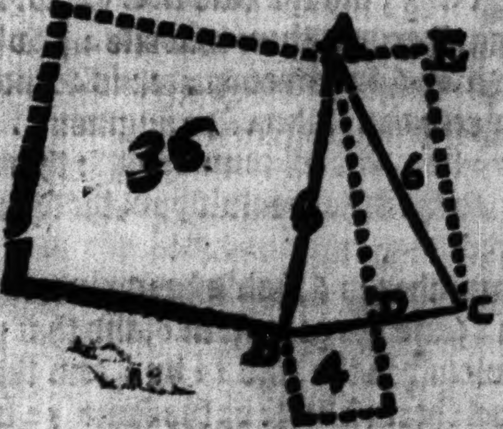
CHAP. XIX.

Of an oxigonium ſcalenum, and to meaſure the ſuperficial content thereof.

De Oxigonio Scaleno.

This tryangle is ſuch a figure that hath all his angles acute as before, the difference from the former riſing in ẏ ſides, for that the other tryangles had ſides equall, in this there is no ſide * equall one unto another, but all unequall, & is meaſured after one way.

Eu.l.1.Def.26



Multiply the perpendicular in halfe the length of the baſe, the product thereof is the area.

Example.

L O, the perpendicular, augmented in M P, or P N, produceth the oblonge, L Q, N O, which is equall to the tryangle L, M, N: whereby you ſee the meaſuring of tryangles for yͤ moſt part, differ not from oblongs, as hereafter.

Corolarium.

Chap. XX.

To meaſure all kinde of ſuperficiall Tryangles generally, and of obtuſed Angles in perticular.

I Thinke it not amiſſe in the concluſion of tryangles to adde a rule, not onely to meaſure the Area of amblygoniums, but generally of any other kinde of tryangle, without the ſeeking of the perpendicular: and the rule is thus.

Regula generalis ad omne triangulorum.

Oron.

Adde together the length of euery ſide of the tryangle, whoſe ſuperficiall capacitie is ſought, and of the totall take halfe: out of this halfe by deduction, noting the difference, that is, how euery ſide differeth from the reſerued halfe: then multiply that halfe by any one of the differences which you will, (but moſt fitly by the greater) & the product thereof augment by any of the other differences: which off-come increaſe by the laſt and third difference, and of the totall take the ſquare roote, which note for the area.

Neither is it materiall in this kinde of worke, which of the three differences you make the firſt, ſecond, or third.

Example.

Let the tryangle be A B C, whoſe left ſide A B is 6 pearches, the right ſide A C 8, and the baſe B C 10: ioyne therefore 10 and 8, and 6 together, and there will riſe 24, whoſe halfe is 12, from which detract 6; ſo the remainder is 6: and 8, there reſteth 4: and 10, ſo 2 remaines: therefore augment 12 in 6, ſo haue you 72, and 72 in 4, the off-come is 288: this number againe multiply by 2, ſo ſhall there reſult 576, the ſquare roote whereof is 24 the area.

The ſame number 576 ſhould be ingendred if you had augmented 12 in 4, and the product in 6, and that product in 2; or if you had multiplyed the ſaid 12 by 2, and the off-come by 4, and the product thereof by 6: or the ſame 12 in 2, the product in 6: and laſtly, the number ingendred in 4: ſo is there allwaies made 576, as you may perceiue by the demonſtration following.

Demonſtration.

The forme of, finding the ſquare roote:

First.	Second.	Third.	Fourth.			
12	12	12	12			
6	4	2	2			
72	48	24	24			
4	6	4	6	$\cancel{1}$	$\cancel{1}$	
288	288	96	144	$\cancel{1}$	$\cancel{7}$	6
2	2	6	4	2		4
576	576	576	576		4	

To performe the ſame Propoſition otherwiſe.

Alia via qua omnis pericer Trianguli area veſtigatur.

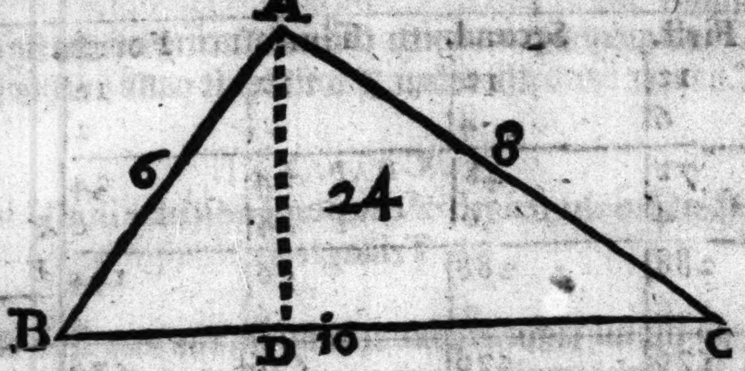
Take the former example; if you multiply 6 in 4, and that product in 2, and againe that product in 12, or if you augment 6 in 2, and the product in 4, and that laſt product in 12, or 4 in 2, and the product in 6, and the reſulting number thereof in 12; there will alwaies ariſe one and the ſelfe ſame number, as 48: which multiply by 12, ſo is there produced 576, according vnto the ſubſcript following.

Subſcript.

First.	Second.	Third.	Fourth.
6	6	4	48
4	2	2	12
24	12	8	96
2	4	6	48
48	48	48	576

Summaria huius Regulæ declaratio.

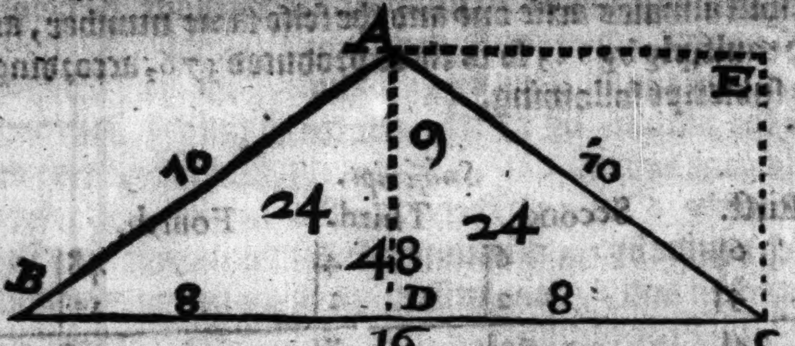
The ſumme of this rule is but adding the three ſides of any tryangle together, and of the reſulting number to take halfe, and then to take the difference that euery ſide ſeuerally doth differ from that compoſe halfe (according to the premonition,) afterwards to multiply one of the differences in the other, and the product in the third difference: and againe, ye product in the halfe of the number aggregated of the compoſition of the ſides, the roote quadrature whereof is your deſire.


A
6
8
24
B
D
10
C

Of an Amblygonium, and to meaſure the Area thereof.

Propoſition 2.

Of Amblygonium or Obtuſanguled tryangles, they be found onely to conſiſt of two differences, that is, an Amblygonia Iſoſceles, and an Amblygonium Scalenum.

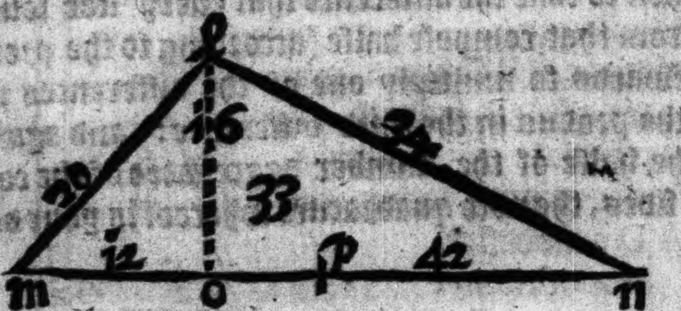

A
E
10
9
10
24
24
48
B
8
D
8
16
C

Eu.1.def.28. Ra.l.8.p.7.

An Amblygonium Iſoſceles is a figure conſiſting of two equall ſides, hauing an obtuſe angle. Meaſure him according vnto the 18 Chap. Def. 2.

Of an Amblygonium Scalenum.

Propoſition 3.


l
16
20
34
33
12
42
m
o
p
n

This Tryangle is ſuch a figure which hath an obtuſe angle as before, differing from the former becauſe all his ſides be vnequall.

This figure agrées with the meaſuring of the figure in the 19 Chapter: and therefore I will let it paſſe in this place. *Eu.1.def.26.*

Chap. XXI.

To find the length of the perpendicular in all kind of Triangles.

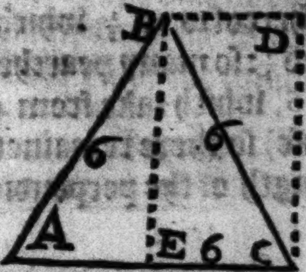
As for all right angled triangles, the one ſide containing the right angle is the perpendicular, and the other the baſe: and therefore there needeth no other rule for that purpoſe then what is ſayd before; for the reſt both Acute and Obtuſe, take theſe inſuing rules.

Propoſition 1.

To find the perpendicular of an Iſophiron oxigonium.

Oxigonium æquilaterum.

If you will worke Arithmetically without the helpe of the 25 Chapter, you muſt multiply one of the equall ſides by 13, and part the offcome by 15: the quotient is your deſire.



Multiply 6 in 13, there is 78, which deuide by 15; ſo haue you B E 5 pearches and $\frac{3}{15}$ your deſire.

Propoſition 2.

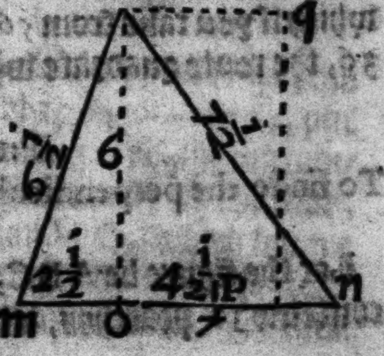
To finde the perpendicular in an Iſoſceles Oxigonium.

Oxigonium Iſoſceles.

Square B D halfe the baſe B C, and then ſquare one of the equall ſides, A B or A C, from which ſquare ſubtract the former ſquare of B D; the roote quadrat of the remainder is your deſire.

Example.

4. The ſquare of B D taken from 36 the ſquare of A B, leaueth 32, whoſe ſquare roote is 5 pearches, and 94 fractions and better, the length of A D your deſire.



Propoſition 3.

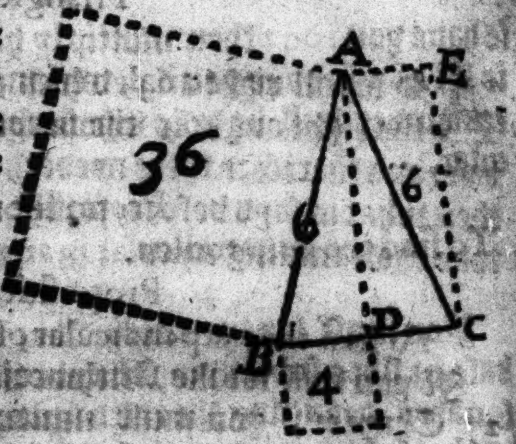
To finde the perpendicular of any Oxigonium Scalenium.

Oxigonium Scalenum.

Firſt ſquare euery ſide, noting the products; this done, adde the ſquare of the baſe vnto the ſquare of the ſhorter ſide of the triangle, and from the offcome detract the third ſquare, noted before: halfe the remainder deuide by the baſe, the quotient whereof ſquare againe, which deduct from the ſquare that you added to the ſquare of the baſe, and note the ſquare roote for the perpendicular.

Example.

Let the Oxigonium Scalenum be L M N, whoſe ſide L M let be $6\frac{1}{2}$ pearches, L N $7\frac{1}{2}$ pearches, and M N the baſe 7 pearches, the ſquare of L M: $6\frac{1}{2}$ is 42, of L N $7\frac{1}{2}$ 56: and of 7 is 49: then the ſquare of 7 added to the ſquare of L M $6\frac{1}{2}$ produceth 91: from which if you abate the ſquare of L N $7\frac{1}{2}$ there remaineth 35: the halfe whereof is $17\frac{1}{2}$, which deuide by 7 the baſe, the quotient is 2 and $\frac{1}{2}$: ſo many pearches is the left ſection M O, whoſe ſquare is 6, which take from 42 (the ſquare added to the ſquare of the baſe) ſo there remaineth 36: the roote quadrate whereof is the length of the perpendicular, viz. 6.



Otherwiſe.

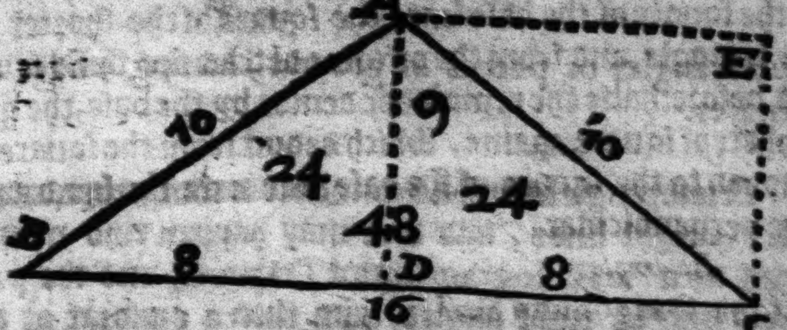
Adde 56 the ſquare of L M to 49 the ſquare of the baſe, ſo haue you 105, from which take 42, the ſquare of L M the other ſide, and there remaineth 63, the halfe of which is 31 and $\frac{1}{2}$, which part by 7 the baſe, the quotient is $4\frac{1}{2}$; ſo many pearches is the right ſection N O: therefore ſquare $4\frac{1}{2}$, ſo haue you 20, which if you take from 56 the ſquare of L N, the remainder is 36, the roote quadrate whereof is 6 pearches, as before.

Prodoſition 4.

To finde the perpendicular in any Ambligonium Iſoſceles.

Ambligonium Iſoſceles.

Let the figure be A B C, let the two equall ſides A B and A C conteine 10 pearches, let the baſe be 16; therefore ſquare 10, ſo



ſo haue you 100: then multiply halfe the baſe in it ſelfe, that is B D 8: ſo haue you 64, which if you deduct from 100, the remainder will be 36, whoſe ſquare roote is the perpendicular.

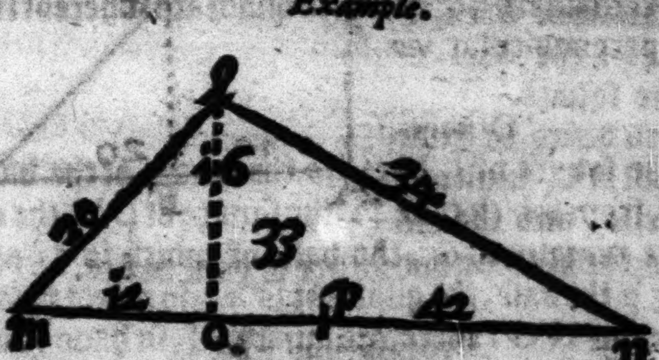
Propoſition 5.

To find the perpendicular in any Amblygonium Scalenum.

You muſt ſquare euery ſide, then adde the ſquare of the baſe or ſides ſubtending the obtuſe angle vnto one of the other ſquares, deducting the third ſquare from the product, and then of that which remaineth: halfe which deuide by the baſe, whoſe quotient you ſhall ſquare, and deduct the ſame from the ſquare which before you added vnto the ſquare of the baſe, the ſquare roote of the remainder is your deſire.

Amblygonium. Scalenum.

Example.



In the triangle L M N, LM is 20, L N 34, M N 42, the ſquare of L M 400, of L N 1156, of M N 1764: — 1764, put to 400, raiſeth 2164, from whence detracting 1156, the remainder is 1008, whoſe halfe is 504, which deuided by 42 the baſe, yeeldeth 12, the length of the left ſection M O, which ſquare maketh 144, and ſubtracted from 400 leaueth 256, the quadrate roote thereof yeeldeth the perpendicular L O, 16: this differeth not from the 3 Propoſ.

Chap. XXII.

Of quadrangles or peeces of ground, hauing 4 ſides and 4 Angles.

Quadrangulum quid.
Eu.l.1.def.22.
Ra.10.pro.4.

A Quadrangle is ſuch a figure that is comprehended vnder * 4 right lines, and that may happen two manner of wayes, as a Parallelogram, and a Trapezia; and the parallelogram may be right angled, and then a quadrat or an oblonge, or oblique-anguled, and then a Rombus or Romboydes, as followeth.

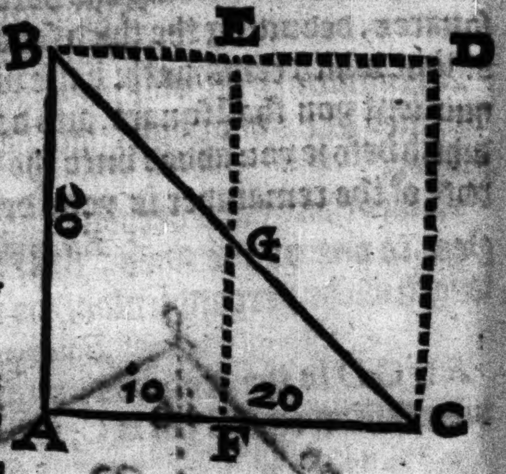
Propoſition 1.

Of a quadrate or ſquare.

Quadratum quid.
Eu l.1.def.30.
Ra.12.p.2.
Ra. 2.conſ.1.
De quadrati area.

A ſquare is a right angled æquilater parallelogram, * whoſe ſides be all equall, as you may perceiue by the figure, and is meaſured thus.

Multiply the knowne ſide of the ſquare in it ſelfe, the product whereof is the Area.



Example.

Multiply A C 20 pearches, one of the knowne ſides, ſo haue you 400, the Area of AB C D, the ſquare.

Inuentio Diagonalis quadratorum.

And if you deſire to finde the diagonall B C, multiply A C in it ſelfe, and the offcome double; the Radix quadrature is your deſire.

Propoſition 2.

Of an Oblonge.

Oblongum quid.
Eu.l.1.def.31.
Ra.13.p.1.

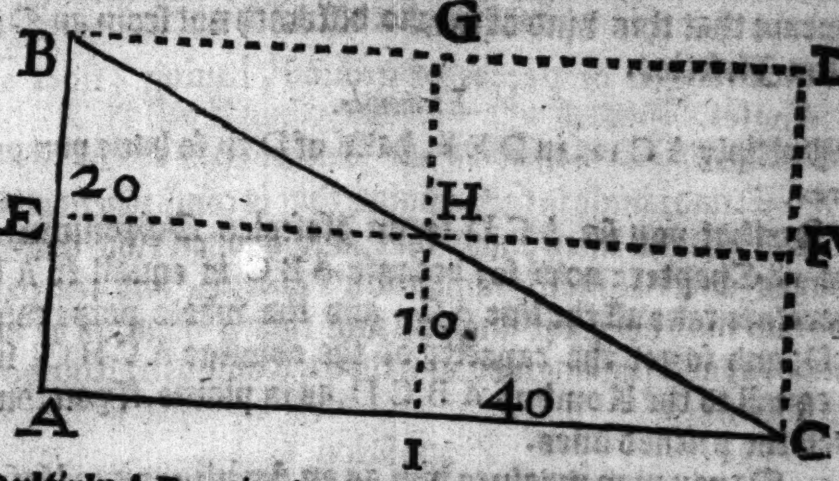
An oblonge is a rect-angled parallelogram, not æquilater, * with ſome, called a long ſquare, whoſe meaſuring followeth.

De menſione quadranguli altera parte longioris.

Take with your ſcale and compaſſe the length of one of the ſhorter ſides, and alſo of one of the longer, which augment one in the other; the off-come is your demaund.

Exam.

Example.



Multiply A B 20 in A C 40, the pꝛoduct is 800 your demaund, viz. the area of the oblonge A B C D.

If you deſire to finde the Diagonall BC, ſquare A C 40, and B A 20, which adde together; the ſquare roote whereof is your deſire.

Vt Diagonalis oblong. inuenitur.

Propoſition 3.
To meaſure a Rombus.

A Rombus is an oblique-angled Parallelogram, æquilater, formed like a diamond, and hath foure kinde of meaſurings pꝛoper.

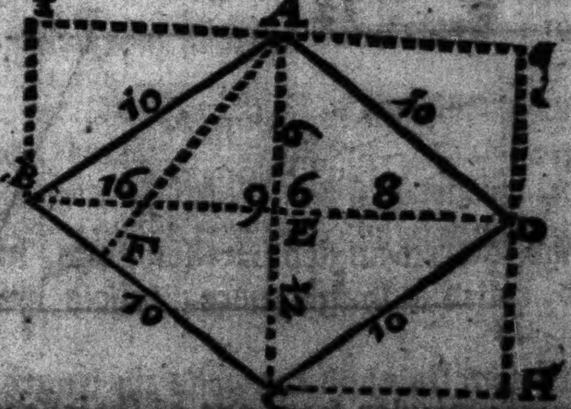
Rombus quid.
Eu.l.1.def.32.
Ra.14.p.8.

1. Let there fall a perpendicular from one of the obtuſeſt angles, to one of the ſides, then multiply the ſame ſide in the length of the perpendicular, the pꝛoduct is the Area.

Rombus qualiter metiatur.

Example.

A B C D is the Rombus, augmented by A F, the perpendicular falling on BC, in B C; ſo haue you 96 pearches.



2. Oꝛ you may meaſure a Rombus by multiplying the whole diſtance betwixt two oppoſite angles in halfe the di-

ſtance betwixt the other two oppoſite angles, whereby it may appeare that this kind of worke differeth not from an Orthogonium Iſoſceles.

Example.

Multiply A C 12, in D E 8, halfe of D B; ſo haue you 96 the Area.

So that you ſee A C D is an Iſoſceles Orthogonium, as in the 18 Chapter: now for becauſe A B C is equall to A D C, therefore take all the line A C, and the whole perpendicular E D; and ſo get the capacity of the oblonge A C H G, which is equall to the Rombus A B C D; as is plaine, if you conſider well the pricked lines.

3. Or you may meaſure him as an Ambligonium Iſoſceles, as in the 20 Chapter Propo. 2. for if you multiply B D the baſe of the Ambligonium Iſoſceles in A E the perpendicular, you haue the oblonge B D G I, which by the preſcript is equall to A B C D the Rombus.

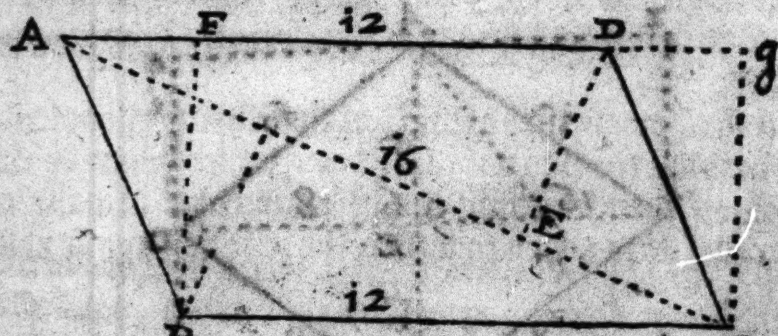
4. Or you may meaſure him as an Orthogonium Scalenum, as in the 16 Chapter Prop. 2: for A E and E D the two ſides containing the right angle, augmented one in the other, produce 48, the contents of the oblonge A E D G, which is equall to halfe the Rombus: therefore double 48, ſo haue you 96, as before.

Propoſition 4.

To meaſure a Romboides.

Romboides.
Eu.l.1.def.33.
Ra.14.p.9.

A Romboides is an oblique-angled parallelogram, not æquilater.



Let fall a perpendicular from one of the longer ſides unto the other, which perpendicular increaſe by one of thoſe longer ſides, ſo haue you your deſire: this differeth not from the 4 Prop. Def. 1.

De Romboides Area.

Example.

ABCD is the Romboydes, BF the perpendicular, which multiplied in BC, produceth the oblonge BCGF, equall to ABCD.

2. Or you may reduce the Romboydes into two triangles by the line AC, and ſo meaſure them as an Ambligonium Scalenum: for DE the perpendicular in the Ambligonium Scalenum ACD, multiplied in AC the Diagonall, produceth the contents of the Romboides.

Propoſition 5.

To meaſure a Trapezium Iſoſceles.

A Trapezium is defined * to be a Quadrilater Triangular, not Parallelogram: therefore we do call that figure a Trapezium, which is neither a parallelogram, neither æquilater, nor æqui-angled. And of Trapezias there be diuerſe ſorts, as well in reſpect of the diuerſity of the ſides, as angles among themſelues: Some doe ſeeme to beare the forme of a perfect Iſoſceles, hauing two equall ſides with two other vnequall, yet parallel with two angles acute, and ſo many likewiſe obtuſe, whereupon he is not vnaptly called an Iſoſceles; and many although they haue two ſides alike equall, or parallel, yet they do admit two right angles: and therefore I will preſume (and not vnworthily) to call ſuch a figure an Orthogonium Trapezium; the reſt of the Trapezias, which admit neither like angles or ſides, I will call an Ambligonium Trapezium. And firſt I will ſpeake of the Iſoſceles Trapezium, and then of the reſt.

Trapezium.
Eu.1.def.23.
Ra.14.p.10.
Trapezium diuerſitas.

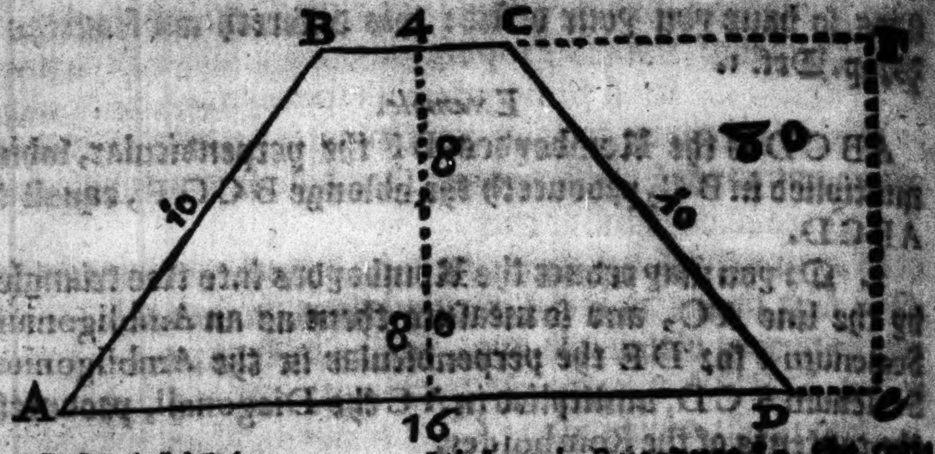
Iſoſceles Trapezium.

Orthogonium Trapezium.

You ſhall meaſure the length of the other perpendicular included betwixt the two parallel ſides, which you may find by the 7 Prop. then multiply the perpendicular in halfe of the two parallel ſides added together; the product is your deſire.

Example.

The perpendicular by the 7 Prop. Def. 1. is found to be 8 in the Trapezia ABCD, the equall ſides are AB and CD, the parallel ſides BC and AD: BC and AD added together, make



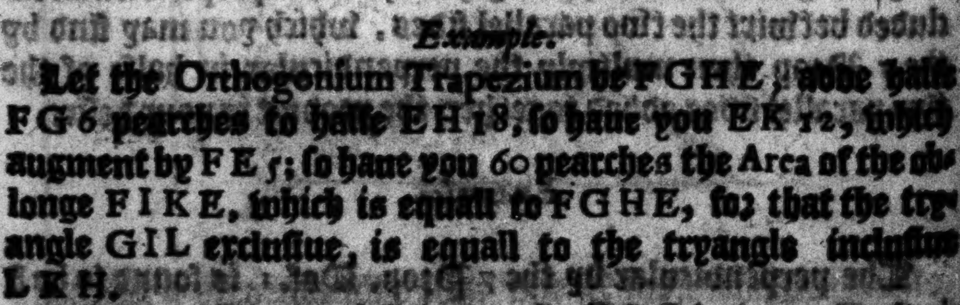
20, halfe which is 10, 10 multiplyed in 8 produce 80, the con
tents of the oblonge 4 F E 16, which is equall to A B C D the
Trapezia: or you may reſolue the Trapezia into two tryan-
gles, and ſo meaſure him by the Doctrine of tryangles be
fore.

Propoſition 6.

An Orthogonium Trapezium.

Vt rectangulum metiatur. Trapezium.

And if it ſhall any thing auaile thee to finde the Area of a
right angled Trapezia, do thus. Adde together the two pa
rallel ſides (whereof the one conteines the right angle,) halfe
which increaſe by the perpendicular or other containing line,
the product is your demaund.



Example.

Let the Orthogonium Trapezium be F G H E, adde halfe
F G 6 pearches to halfe E H 18, ſo haue you E K 12, which
augment by F E 5; ſo haue you 60 pearches the Area of the ob
longe F I K E, which is equall to F G H E, for that the try
angle G I L excluſiue, is equall to the tryangle incluſiue
L K H.

Or you may reſolue this figure into a tryangle as before.

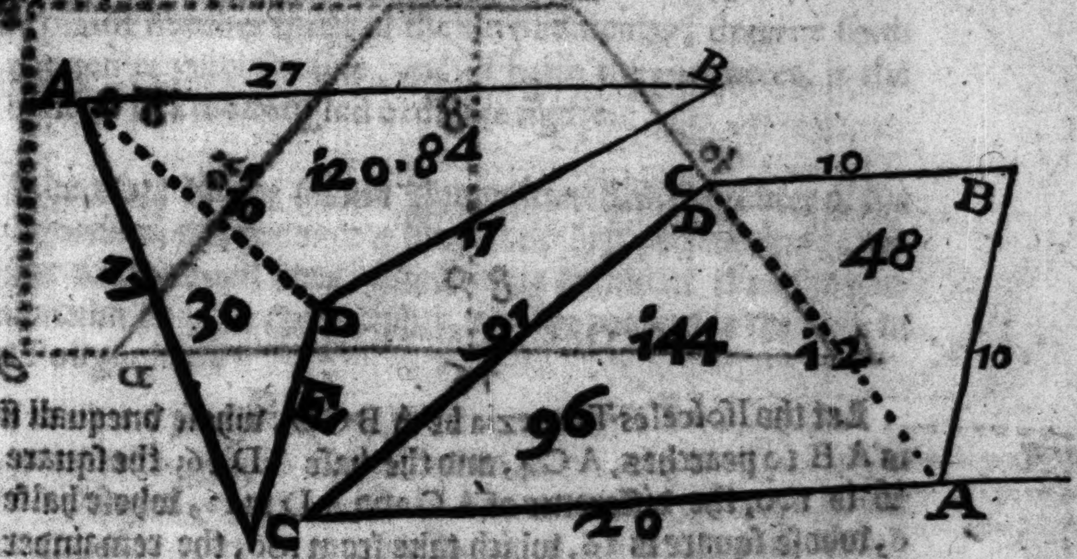
Propo

Propoſition 7.

An Ambligonium Trapezium.

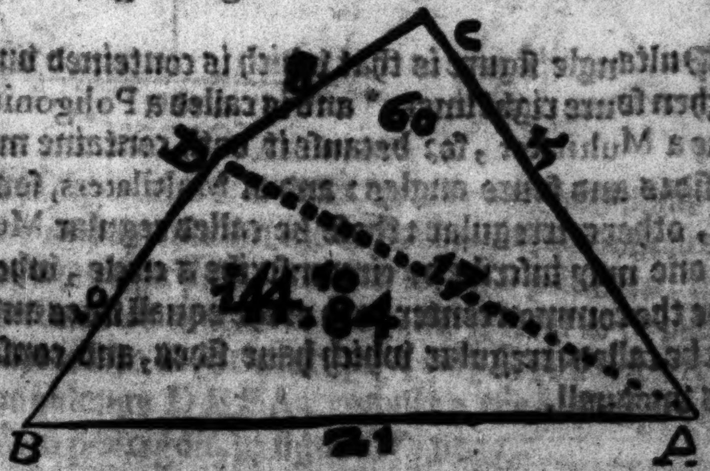
This figure may happen after diuerſe manner of wayes: but for all I will ſet downe onely three differences, whoſe meaſuring are all one kind of way.

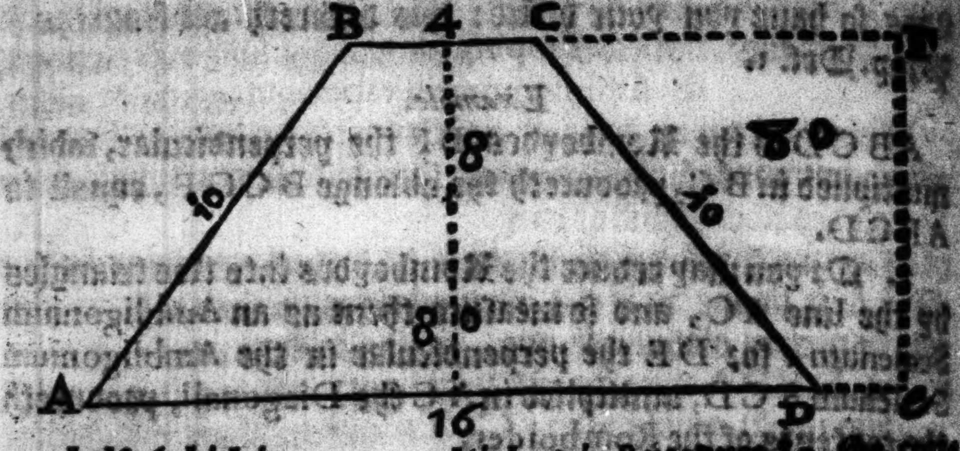
You muſt reſolue each figure into two tryangles by the ſhorteſt diagonall you can, then meaſure thoſe two tryangles by the former inſtruction of tryangles.


A
27
B
120·84
30
17
17
D
E
C
20
91
144
96
C
D
10
B
48
10
12
A

Example.

These three Trapeziums A D C D are reſolued into two tryangles by the Diagonall A D, and then meaſured by the preſcript of triangles; and A D is the ſhorteſt Diagonall that can be found.


C
60
5
D
9
17
144·84
10
B
21
A



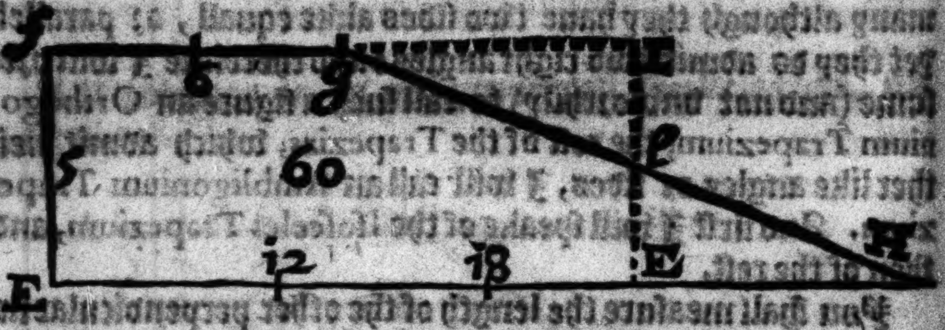
20, halfe which is 10, 10 multiplyed in 8 produce 80, the contents of the oblonge 4 F E 16, which is equall to A B C D the Trapezia: or you may reſolue the Trapezia into two tryangles, and ſo meaſure him by the Doctrine of tryangles before.

Propoſition 6.

An Orthogonium Trapezium.

Vt rectangulum metiatur. Trapezium.

And if it ſhall any thing auaile thee to finde the Area of a right angled Trapezia, do thus. Adde together the two parallel ſides (whereof the one conteines the right angle,) halfe which increaſe by the perpendicular or other containing line, the product is your demaund.



Example.

Let the Orthogonium Trapezium be F G H E, adde halfe F G 6 pearches to halfe E H 18, ſo haue you E K 12, which augment by F E 5; ſo haue you 60 pearches the Area of the oblonge F I K E, which is equall to F G H E, for that the tryangle G I L excluſiue, is equall to the tryangle incluſiue L K H.

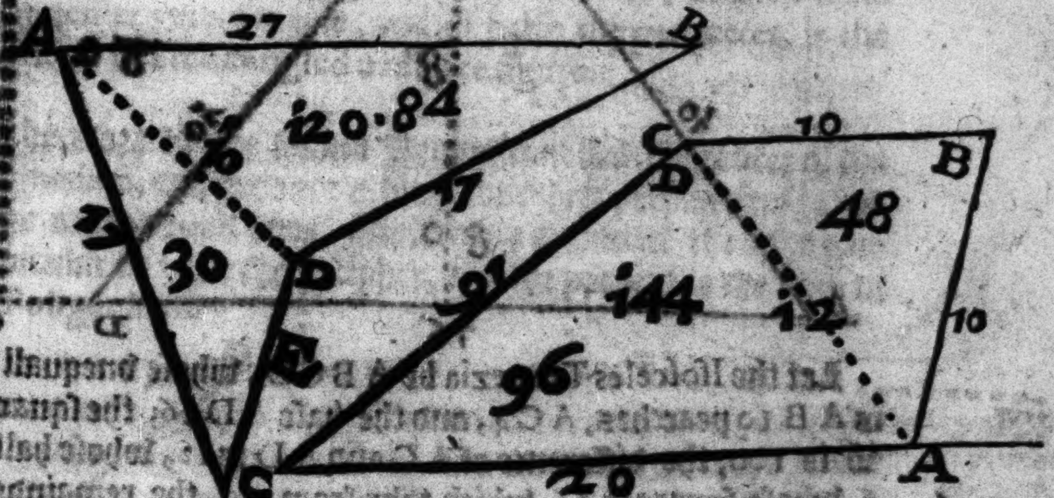
Or you may reſolue this figure into a tryangle as before.

Propoſition 7.

An Ambligonium Trapezium.

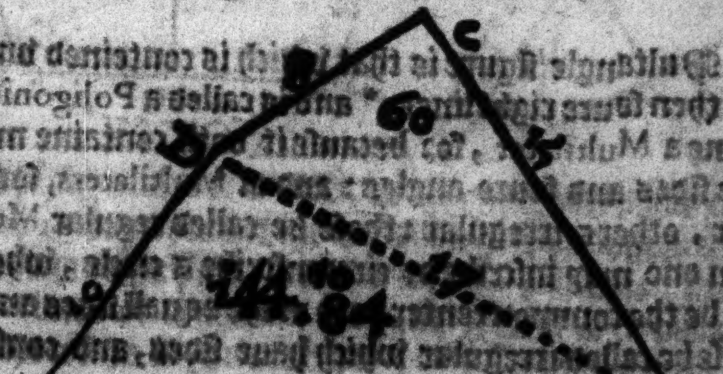
This figure may happen after diuerſe manner of wayes: but for all I will ſet downe onely three differences, whoſe meaſuring are all one kind of way.

You muſt reſolue each figure into two tryangles by the ſhorteſt diagonall you can, then meaſure thoſe two tryangles by the former inſtruction of tryangles.


A
27
B
120.84
10
C
B
D
17
48
27
30
D
91
144
12
10
E
96
C
20
A

Example.

These three Trapeziums A D C D are reſolued into two tryangles by the Diagonall A D, and then meaſured by the preſcript of triangles; and A D is the ſhorteſt Diagonall that can be found.

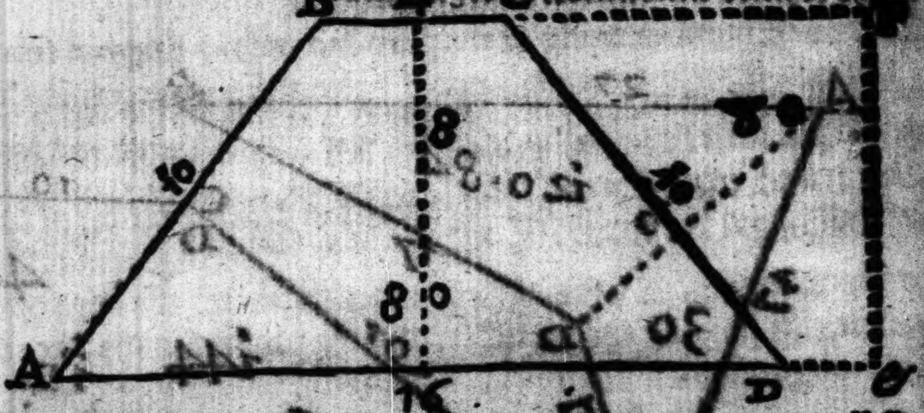

C
60
D
15
17
9
144.84
B
21
A

Propoſition 8.

To find the perpendicular in an Iſoſceles Trapezium:

You ſhall multiply one of the equall or diſparallel ſides in it ſelfe, and reſerue the product, then ſquare halfe the difference of the two parallel ſides, and ſubtract the product from the firſt reſerued number: the ſquare ſide or roote whereof is the perpendicular.

Example.



Let the Iſoſceles Trapezia be A B C D, whoſe vnequall ſide is A B 10 pearches, A C 4, and the baſe A D 16, the ſquare of 10 is 100, the difference of A C and A D is 12, whoſe halfe is 6, whoſe ſquare is 36, which take from 100, the remainder is 64, whoſe radix is 8 your demaund. And thus farre of Quadrangles.

Chap. XXIII.

Of a Polygonium, and to find the center and ſuperficiall content thereof, as alſo to meaſure irregular figures.

Multangula.
Eu.l.1.def.23.
Ra.14.p.11.
Oron.

A Multangle figure is that which is conteined vnder more then foure right lines, and is called a Poligonium, and of ſome a Multilater, for becauſe it doth containe more then foure ſides and foure angles: and of Multilaters, ſome be regular, others irregular: thoſe be called regular Multilaters, when one may inſcribe or circumſcribe a circle, whoſe center ſhall be the common center both of the equall ſides and angles. Thoſe be called irregular which haue ſides, and conſequently angles vnequall.

Regulares multilatera figura.

Irregulares.

Pro-

Propoſition 1.

To meaſure a Regular Poligonium.

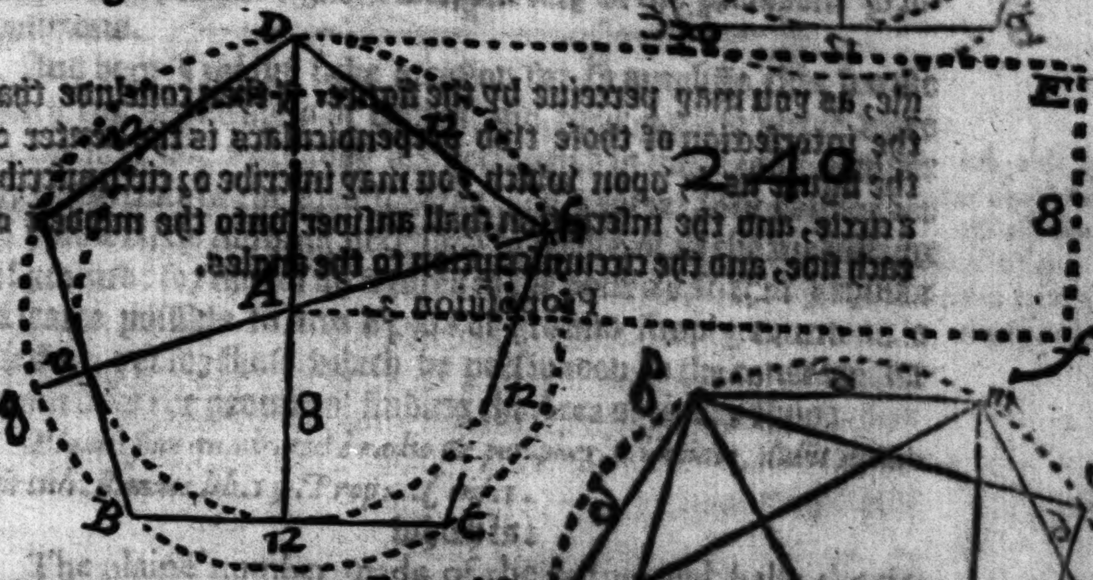
When you would find the Area of any regular Poligonium or Multilater, obſerue then this generall rule.

Si fiat planum è perpendiculari à centro in latus, & dimidio perimetro, factus est area multanguli ordinati: Oron cap. 8. lib. 2. De Geo. & pract. Geomet. Ral. 19. P. 1.

Which is Engliſhed thus:

The plaine number made of the perpendicular, drawne from the center vnto the ſide, and of halfe the perimeter, is the content of a multangled ordinate figure.

Therefore by the ſecond Propoſition find the center of the Poligonium, and produce a line from thence perpendicular vnto one of the equall ſides, afterwards augment the ſaid perpendicular in halfe the peripher, and the product is the Area of the Poligonium.



Example.

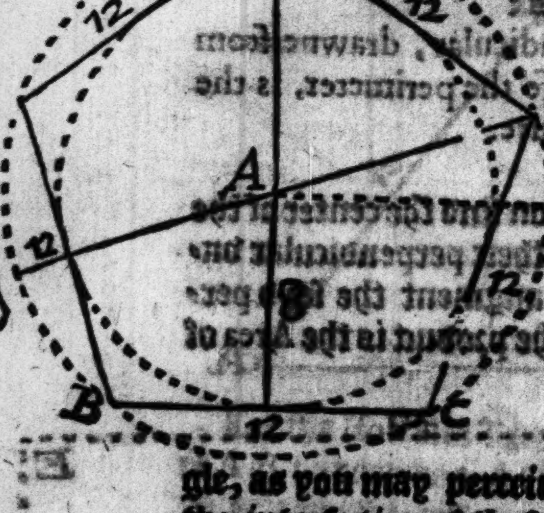
Let the poligonium A B C D, be a Pentagon, whoſe equall ſides let be 12 pearches, let the center be A, from whence draw a line perpendicular to B C, which let be 8 pearches: then by because 5 times 12 make 60, the halfe thereof is 30 pearches, as DE: therefore if you multiply 30 by 8, you haue the content of the oblonge D E F A, equall by the preſcript vnto the polygonium pentagon, or figure of 5 ſides.

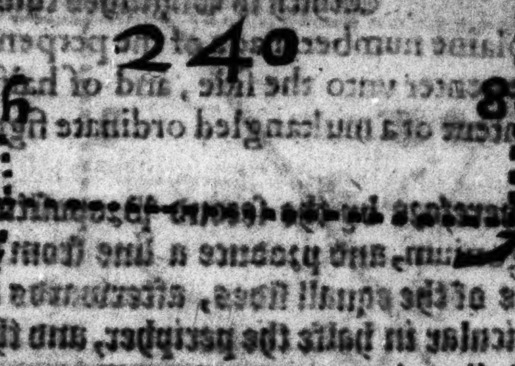
Propoſition 2.

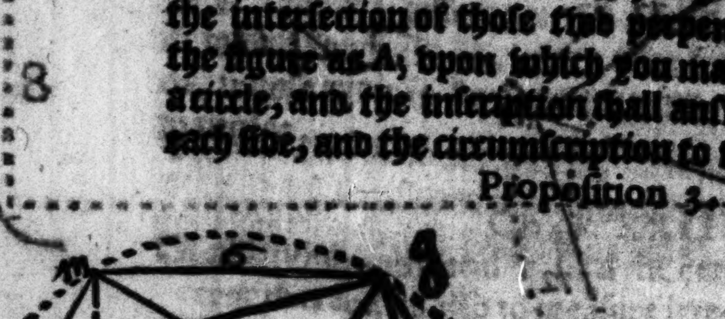
To find the center of a polygonium hauing an odde ſide.

If the figure haue an odde ſide, as the pentagon in the laſt Prop. find his center thus.

Let fall a perpendicular from one of the angles vnto his oppoſite ſide, as from D on the line B C, do ſo to ſome other an-

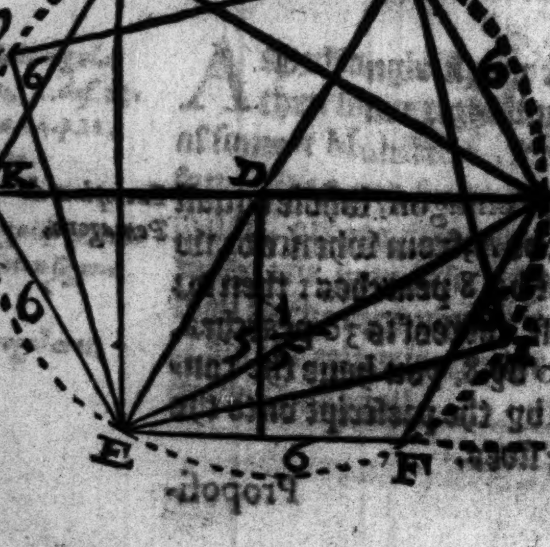


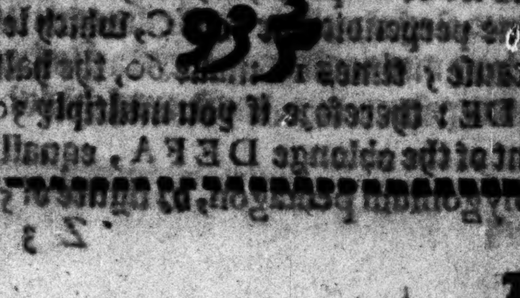




gle, as you may perceiue by the figure. I then conclude that the interſection of thoſe two perpendiculars is the center of the figure as A, vpon which you may inſcribe or circumſcribe a circle, and the inſcription ſhall anſwer vnto the middeſt of each ſide, and the circumſcription to the angles.

Propoſition 3.





To finde the center of any polygonium containing equall ſides.

You muſt draw two lines betweene any oppoſite angles, the interſection is the center, ſo ſhall you finde D to be the center of the hexagon D E F H G M K; then the perpendicular is $5\frac{1}{7}$, which augment in 30 halfe the peripher, ſo haue you $93\frac{2}{7}$ pearches, the content of the Hexagon Poligonium.

Exemplum De Hexagono.

And thus farre of regular poligoniums, preſuming I haue ſayd ſufficient for the perfect underſtanding thereof.

Propoſition 4.

Of irregular Polygoniums, called irregular figures.

There can be no other rule be preſcribed then to reſolue ſuch irregular figures into ſome regular forme: for which purpoſe the 44 Chapter and 8 Metamorphis ſhall ſtand you in a ſingular vſe: therefore I will ceaſe here to ſpeake further thereof: and indeed by that chapter you may meaſure all kind of ordinate or inordinate figures without any of the precedent Propoſitions.

And here I might take occaſion for to ampliſie this worke with the dimenſions of circles and their parts: but it were vaine ſo to do, ſince they are performed in more eaſie manner by my Staffe in the preallegated 44 Chapter: But howſoeuer I hold a circle nothing neceſſary to treate of in the meaſuring of ground: for that of all figures is the perfects, ſo that I thinke it ſcarce poſſible to find a peece of ground ſimply round as a circle: yet for thoſe which be perſwaded to the contrary, let them take the ground of finding the Area of circles thus:

Planus ſiue quadratus è radio & peripheria dimidio, dabit aream circuli. Ramus lib. 19. Prop. 2. Conſ. 1.

which is:

The plaine number made of the radius and halfe the circumference, is the content of a circle.]

Chap. XXIIII.

To reduce pearches vnto acres, and ſuch like Statute meaſure.

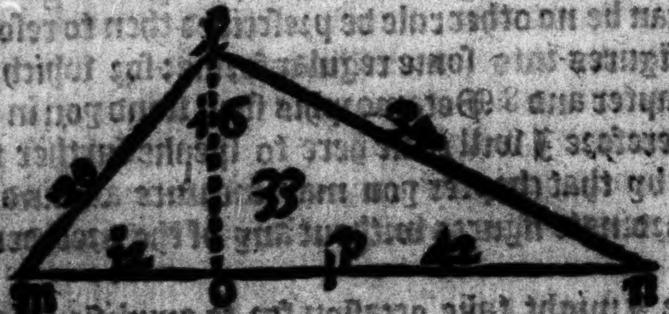
VVhen you haue multiplied your figures, as before, and found the true quantity of pearches therein,

you

To reduce perches vnto acres and ſtatute meaſure.

you ſhall reduce them vnto acres, rods, &c. according vnto the ſecond Chapter of the ſecond booke, thus. If the number of pearches exceed 160, deuide the ſayd number by 160, the quotient ſheweth the number of acres, then if there be any thing remaining, if it exceed 40, make partition thereof by 40, ſo ſhall the quotient ſhew the number of roodes, then if there be any thing remaining deuide it by 4, the quotient is the number of dayworkes, and the remainder the number of pearches, and if after partition by 160, 40, or 4, the number remaining be leſſe then 4, it is pearches.

Example.



By this doctrine you may augment the Tables of land meaſure as far as you pleaſe.

By the doctrine of the 20 Chapter, Prop, 3. I find the perpendicular L O 16 pearches, and the baſe M N 42, then by the foreſayd doctrine of tryangles I augment halfe M N 21 in L O 16, ſo haue I 336 pearches, which by the preſcript of this Chapter I firſt deuide by 160, ſo haue I 2 for my quotient, and 16 remaining: then becauſe 16 will not ſuffer partition by 40, I part it by 4, ſo haue I 4 for my quotient, and nought remaining: whereby I may conclude that the tryangle L M N, doth containe 2 acres, 0 roodes, 4 dayworkes and 0 pearches.

Chap. XXV.

To meaſure all manner of land without Arithmeticke, or to render the contents of the plat taken.

To meaſure ground without Arithmeticke.

I Am not ignorant that diuerſe neuer yet ſtudied in the Art of Arithmeticke or Geometry will notwithſtanding be very deſirous to haue a ſight in this Art of Geodetia or meaſuring ground, which if perchance let ſuch worke thus.

If the figure be irregular, reſolue him into tryangles (becauſe experience teacheth me, and Geometry confirmes the ſame, that there is no figure how irregular ſoeuer, but may be reſolued into tryangles:) but if the figure be a tryangle it ſelfe, you ſhall ſéeke out the greateſt angle: wherein place the firme ſote of your Compaſſe, extending the other ſo that you may take the ſhorteſt extenſion betwixt the ſayd angle, and the baſe line that doth ſubtend the angle: this wideneſſe of your Compaſſe you ſhall apply vnto your Scale, and ſée how many pearches it containes; for ſo many equall parts as be included betwixt the two féete of your Compaſſe, ſo many pearches long is the perpendicular: then take the length of the baſe, and note the halfe thereof, and ſo by the 27 Chapter enter the table with thoſe two numbers, and you haue your deſire.

To find the perpendicular, in tryangles without Arithmeticke.

Example.

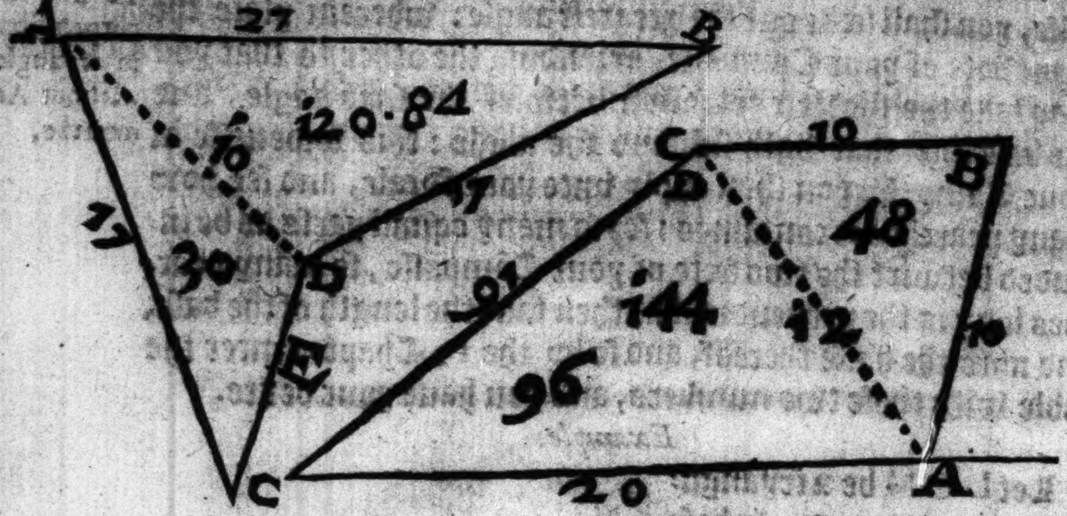
Let L O M be a tryangular peece of ground, whoſe baſe M N is 7 pearches, and whoſe perpendicular L O is 6 pearches, which is the ſhorteſt extenſion betwixt the angle L, and the line M N: then I enter my table according to the 27 Chapter, with 6 and 3 ½, which is halfe 7. But firſt becauſe there be fractions annexed, I enter with 6 and 3, ſo do I find 2 day-work and 1 pearch: then for the ½ or halfe the pearch annexed to 3, I enter the table according vnto the 28 Chapter: ſo do I find 3 pearches more, which added vnto the former, viz. to 2 day-worke, and one pearch make 2 day-worke, and 4 pearch: which by the laſt Chapter is iuſt 2 ½ day-worke, or halfe a rode, the content of L M N.

Which is as if you had multiplied 6 by 3 ½ and proceeded as in the 19 Chapter.

And heare let it be noted generally, when you reduce your plat into tryangles, make them as bigge as you may, and ſo conſequently as few as you can: for looke how many angles the plat containes, (if you worke truly) there will be two leſſe tryangles therein; as if the plat conſiſt of 6 angles, the tryangles

Note.

angles therein will be but 4; if of 4, the tryangles will be 2, as you ſee in the enſuing figures by the line A D.


A
27
B
10
120.84
17
17
30
D
E
C
91
96
144
20
C
D
10
B
48
12
10
A

Chap. XXVI.

Of the meaſuring of a Trapezia, Rombus, Romboides, &c. without Arithmeticke, or an oblonge, &c. alſo to meaſure all lands without plaining.

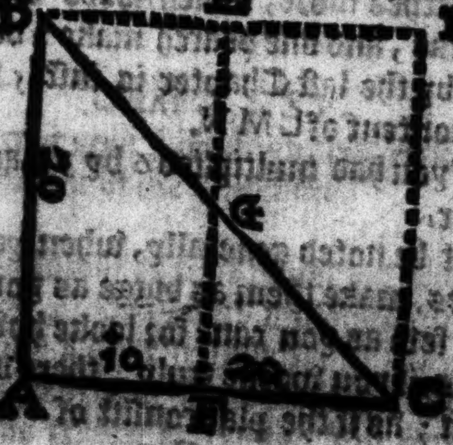
You may reſolue any of all theſe figures into two tryangles by the 7 Propoſition of the 22 Chapter, and ſo meaſure them as in the laſt Chapter; or otherwiſe worke thus.

Propoſition 1.

For a ſquare.

A Square.

Let A B C D be a ſquare: by my ſcale and compaſſe I find


B
E
D
10
G
10
20
A
F
C

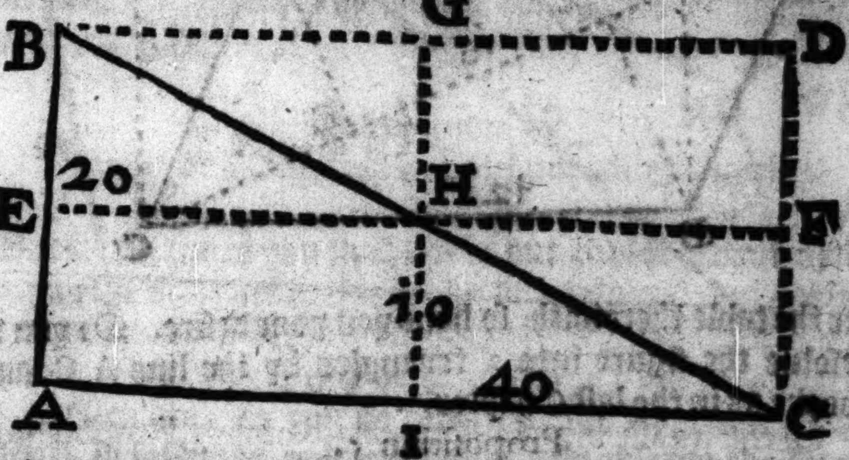
AB to conteine 20 pearches, with which entring the table by the 27, with 20 and 20 I haue my deſire, viz. 2 acres and 2 roodes.

Propoſition 2.

For an Oblonge.

An Oblonge.

Let A B D C be a long ſquare: as before, I find A B 20 pearches, and A C 40, with which entring the enſuing table



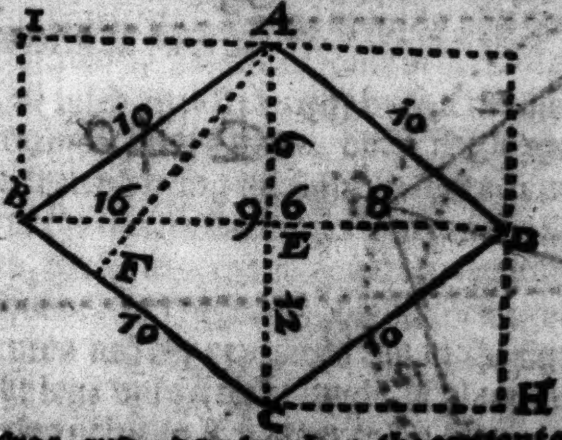
according to the 27 Chapter, I find 45 acres the content of A B D C; and you might haue reſolued the figure into 2 tryangles by the line B C, and meaſured him, as in the laſt chapter.

Propoſition 3.

For a Rombus.

A Rombus.

Let a figure be giuen A B C D, like vnto a Diamond: by my Scale and Compaſſe I find B D 16 pearches, and the line A C 12: enter the table with 8, halfe B D, and 12, the whole of A C:



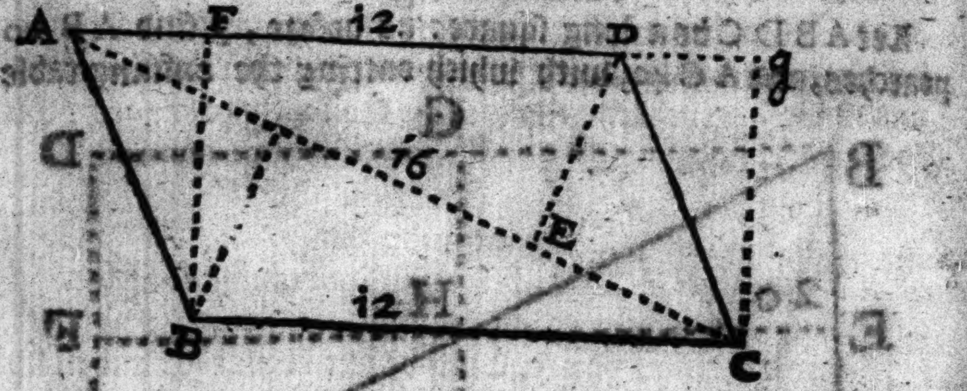
ſo haue I 2 acres, and 4 day-workes, the contents of A B C D: or you might haue reſolued it into tryangles, according as you ſée the pricked lines, and ſo wrought by the 25 chapter.

Propoſition 4.

For a Romboides.

A Romboides. *Vide prop. 4. cap. 22.*

Foꝛ a Romboides, looke what numbers I bid you multiply one in the other, the ſame find by the laſt Chapter, and enter the table therewith; ſo haue you your deſire. Oꝛ you may reſolue the figure into 2 tryangles by the line A C, and ſo woꝛke as in the laſt Chapter.



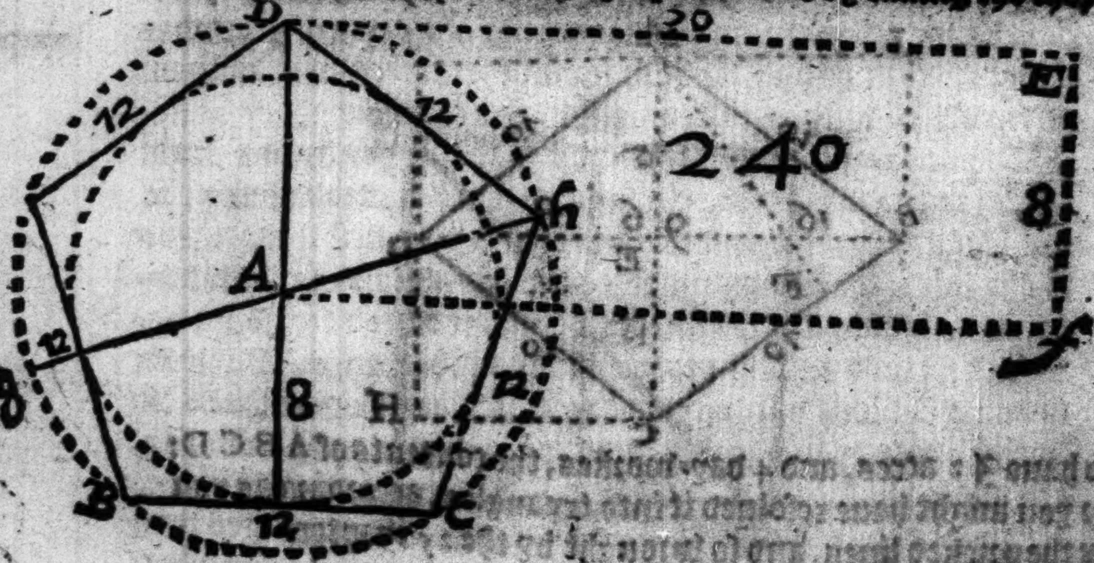
Propoſition 5.

A Generall Rule.

In bꝛiefe looke what numbers I bid you multiply one in the other, the ſame find by your Scale and Compaſſe, and ſo enter the enſuing table, and you ſhall haue your deſire.

Example.

We will take this Poligonium Pentagon, oꝛ figure of fiue ſides A D G B C H: firſt by the 23 Chapter Pꝛop. 2, I finde his center A, then I find the perpendicular by taking the ſhoꝛ-



teſt extenſion betwixt A and one of the equall ſides, as B C: let the perpendicular be 8 pearches, then I ſearch the length of the 5 equall ſides with my Scale and compaſſe, which let be 12 apeece, the whole peripher D B C H making 60, the halfe whereof is 30: ſo I enter the table with 8 the perpendicular, and 30 halfe the peripher, and find one acre and two roodes, which is the contents as truly as if I had increaſed 30 by 8, and found 240 pearches, which by the 24 chapter agrées with the former.

Propoſition 6.

To meaſure all kind of land without taking the plot.

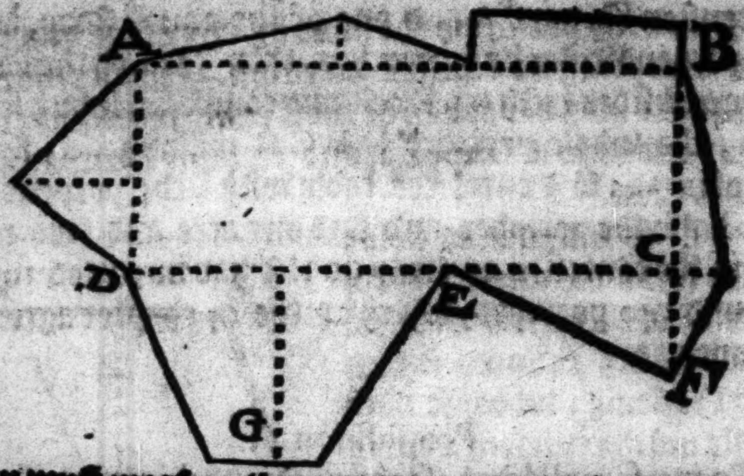
To meaſure land without platting.

But many times you ſhall not be put to plot ground in ſuch order as the firſt part of this booke directeth you, but onely to yeeld the contents of the peece of land in the field according to the dimenſion there taken by your chaine, and ſo to ingroſſe the particulars, as you be taught in the Appendix; which when it ſo fortunes, you muſt diligently obſerue the formes and diuerſe faſhions of the ſayd grounds, and ſo reduce it into ſome one regular figure or other, as into a ſquare, a tryangle, or tryangles, a Trapezia or ſuch like, and then meaſure it as before. But in ſo much ẏ many, or rather moſt peeces of land beare no regular figure, there be diuerſe wayes that I haue vſed for the meaſurement of the ſame.

To ſquare a peece of land.

Firſt, you may take your inſtrument and ſquare the fielde, and then meaſure the odde peeces by it ſelfe, according to the figure they repreſent: and this ſquaring of a peece of ground is either performed by ẏ ſtaffe or ſome other inſtrument without an needle, or with an inſtrument with a needle.

To performe it by the ſtaffe, open the legges vnto a right angle, and then planting the ſame in foure ſeuerall places the one legge at the ſecond ſtation, reſpecting the firſt ſtation, and ſo the third, the ſecond, the irregular ſuperficies is reduced into a true ſquare, the fragments being meaſured according vnto ſuch figures as they repreſent: as in the figure A B F E D, opening the legs vnto a right angle, I place them firſt at A, ſo doth ẏ one leg point to B, ẏ other to D: then placing him at D, the one leg points to A, ẏ other to C. Laſtly placing at C, ẏ one leg points to D, ẏ other to B, ſo haue you made a perfect long ſquare parallelogram. As for the fragments and corners omit-



ted, you muſt meaſure them as I ſayd, according to the figure that they repreſent, as you may plainely perceiue by the figure before, and by the pricked lines inſcribed therein.

If you conceiue this forme, you may alſo performe the ſame by the Theodelitus or Topographicall Glaſſe, &c.

Propoſition 7.

To find where the perpendicular in any tryangle fals vpon the baſe, without Arithmeticke, in the open field.

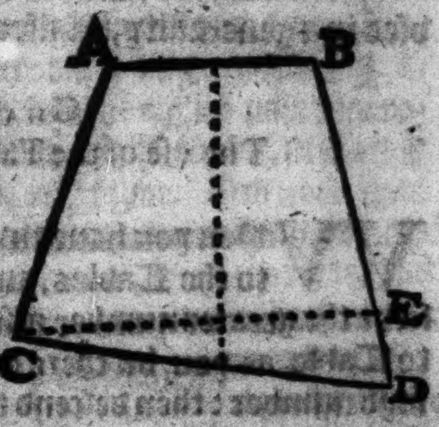
To finde where the perpendicular in any Tryangle fals vpon the baſe.

Now in platting of grounds, when there happen tryangles, you muſt of neceſſity find the perpendicular, and for that it is troubleſome to performe it Arithmetically, you ſhall therefore performe the ſame by any of theſe enſuing wayes.

1. Open the legges to a right angle, and then place the one legge iuſt ouer the line ſubtending the greateſt angle, mouing the Inſtrument from place to place (keeping the ſayd one leg ſtill ouer the ſayd line) vntill the other poynt iuſt in to the angle oppoſite to that line: ſo then doth the inſtrument ſtand in the place where the perpendicular ſhould fall: therefore meaſure from thence in to the ſayd angle, ſo haue you your deſire.

2. Or obſerue the angle at one of the ends of the ſubtending line, and then (the legges reſting at that angle) meaſure the other ſide conteining the ſayd angle, which count vpon the right legge: now placing the graduator at a right angle, draw him along the left legge, vntill the fiduciall edge thereof cut the parts before numbred vpon the right legge: ſo doth the center of the graduator vpon the left legge cut the number of pearches, that the perpendicular falleth vpon the baſe line, being counted from that end you obſerued the angle at.

3. You may performe the ſame by any of the other inſtruments, according to the firſt direction. Furthermore the figure oppoſite may happen to be moſt eaſily meaſured, by reducing the ſame vnto a Trapezia, and certaine figures, the which performe thus.



ABCD is a figure or fielde propoſed to be meaſured. Here you ſee that this field may be well and eaſily reduced into a perfect Trapezia, which it doth of it ſelfe much repreſent: but is not perfect: for that CD and AB be not parallel: therefore to make a true Trapezia thereof, or to proue if the two oppoſite ends lye parallel, do thus.

Plant your Topographicall Glaſſe at A, making the needle ſtand iuſt in his true place, then moue the Index or Alhidada, vntill through the ſight you ſee B: note the degree cut, which let be 200, then plant him in the leſſer of the angles at the end of the line CD, as at C, making againe the needle to ſtand ouer his right place, bringing alſo the Index vnto the degree cut before, viz. 200: ſo do the ſights poynt to E, whereby you haue made a true Trapezia ABCE, which meaſure accordingly; then for the tryangle DEC, meaſure the ſame according to the doctrine of tryangles.

By this meanes may you drawe parallels in any kind of figure conceiued in the fields, and ſo reduce the ſame into what figure ſeeming moſt fit and requiſite, as a Quadrate, an Oblonge, a Rombus or Romboides, which are all figures conſiſting of parallel ſides.

Likewiſe may you drawe any lines ſloping out one as much as another, as from the poynt B, to drawe the line BE to ſlope out as much as the line AC doth at the poynt A: hereby alſo haue you made the angle CAB, equall to ABD.

In this order muſt you worke when you be put to meaſure landes without platting, ſtill by your inſtrument reducing the propoſed field, or paſture into certaine exact and regular figures: for it is moſt abſurd and direct contrary to the groundes of Art, to giue credit vnto the meaſuring that many countrie fellowes vſe. For you ſhall ſee a Maſon, Carpenter, or ſome

Many meaſure grounds falſly.

ſuch Mechanicall fellow vndertake to meaſure and truly deuide his neighbors grounds, when as his rules be moſt falſe and vncertaine. For ſome vſe to meaſure round about the ground without regard of any regular or irregular figure it repreſents: others vſe to meaſure all kind of lands as we do a Trapezia: others take halfe the ſides and ends, all which to be vſed in a generallity, is falſe and abſurde.

Chap. XXVII.

The vſe of the Table for land meaſuring.

WHen you haue two numbers aſſigned, the reſort vnto the Tables, and in the vpper end or head thereof ſéeke the greater number aſſigned, going forwards from Table to Table, as you be there directed, vntill you haue found the ſayd number: then deſcend that columne vntill you come ſo low that you are iuſt againſt the leſſer aſſigned number in yͤ deſcending row vpon the left hand: ſo in the common angle or ſquare where the concourſe of both lines meete, you ſhall find placed in the ſayd ſquare the number of acres, roodes, day-workes or pearches, as the plat containes.

Example.

I find by the doctrine before, that the length of ſome perpendicular is 15 pearches, and the halfe of ſome baſe 20 pearches: I find 15 in the ſide of the table, and ſo proceeding vntill I come right vnder 20, in the vppermoſt columne: there then in the common angle do I find 1 acre, 3 roodes, and 5 day-worke, and ſo of any other number.

To worke when the numbers exceede the tables.

And if the numbers exceed your table, make partition thereof taking the halfe 3 degrée, part or quarter; and ſo enter the Table, and then proportien what you find according vnto the parts you tooke.

Example.

The one number exceeding the Table.

My one number is 100, the other 8, I can find 8, but not 100 in my table: therefore I take the fourth part of 100, which is 25, entring my table with 8 and 25, ſo do I find one acre, and one roode, which take 4 times, becauſe I tooke the fourth part, ſo haue I iuſt 5 acres: or you might haue taken halfe and ſo entred with 50 and 8, ſo ſhould you haue found two acres, and two roodes, which doubled amounts, as before.

Now it may happen that both the numbers ſhall exceede the Table, let the two numbers be 100 and 100; ſuppoſe I cannot find them in the Table, take therefore what parts you will thereof, I take halfe of the one, and the fourth part of the other, halfe 100 is 50, the fourth part is 25: I enter my table with 50 and 25, and find 7 acres, 3 roodes, 2 day-workes, and 2 pearches: then becauſe I tooke 2 parts of the one number, and the fourth of the other, I increaſe 4 by 2, ſo haue I 8, which argueth that I haue found but the eighth part: therefore muſt I take the foreſayd number eight times, ſo ſhall I haue 62 acres, and 2 roodes, ſo of any other. And note that each ſquare hath foure numbers therein contained, ſignifying as followeth:

Of the foure numbers, the
- upper
  - leftwards
  - rightwards
- lower
  - leftwards
  - rightwards

conteines
- acres.
- roodes.
- day-workes.
- pearches.

Table 1.

This row proceedes in the 2 Table.

	1	2	3	4	5	6	7	8	9	10
1	1	2	3	1	1 1	1 2	1 3	2	2 1	2 2
2		1	1 2	2	2 2	3	3 2	4	4 2	5
3			2 1	3	3 3	4 2	5 1	6	6 3	7 2
4				4	5	6	7	8	9	1
5					6 1	7 2	8 3	1	1 1 1	1 2 2
6						9	1 2	1 2	1 3 2	1 5
7							1 2 1	1 4	1 3 3	1 7 2
8								1 6	1 8	2
9									2 1	2 2 2
10										2 5

This Table doth extend from 1 perch to 10, in breadth and length; the left row proceeding in the 2 Table, at 11.

You moſte note that theſe words belowe euery Table, (In Table) doe note in what Table both the ſides of that Table are continued togethe.

Table 2.

This rowe proceedes in the 3. Table.

	11	12	13	14	15	16	17	18	19	20
1	2 3	3	3 1	3 2	3 3	4	4 1	4 2	4 3	5
2	5 2	6	6 2	7	7 2	8	8 2	9	9 2	10
3	8 1	9	9 3	10 2	11 1	12	12 3	13 2	14 1	15
4	11	12	13	14	15	16	17	18	19	20
5	13 3	15	16 1	17 2	18 3	20	21 1	22 2	23 3	25
6	16 2	18	19 2	21	22 2	24	25 2	27	28 2	30
7	19 1	21	22 3	24 2	26 1	28	29 3	31 2	33 1	35
8	22	24	26	28	30	32	34	36	38	40
9	24 3	27	29 1	31 2	33 3	36	38 1	40 2	42 3	45
10	27 2	30	32 2	35	37 2	40	42 2	45	47 2	50
11	30 1	33	35 3	38 2	41 1	44	46 3	49 2	52 1	55
12		36	39	42	45	48	51	54	57	60
13			42 1	45 2	48 3	52	55 1	58 2	61 3	65
14				49	52 2	56	59 2	63	66 2	70
15					56 1	60	63 3	67 2	71 1	75
16						64	68	72	76	80
17							72 1	76 2	80 3	85
18								81	85 2	90
19									90 1	95
20										100

This ſide proceedes from 20. in the 5. Table to 50.

In Table 4.

Table 3.

This rowe proceedes in the 4. Table.

	21	22	23	24	25	26	27	28	29	30
1	5 1	5 2	5 3	5	6 1	6 2	6 3	7	7 1	7 2
2	1 2	1 1	1 1	1 2	2 2	1 3	1 3 2	1 4	1 4 2	1 5
3	1 5 3	1 6 2	1 7 3	1 8	1 3 3	1 9 2	2 1	2 1	1 3	2 2 2
4	3 1	2 2	2 1	2 4	2 5	2 6	2 7	2 8	3 9	3
5	2 6 1	3 7 3	3 8 8	3	3 1 1	3 2 2	3 3 3	3 5	3 6 1	3 7 2
6	3 1 2	3 3	1 4 2	1 6	1 2	3 9	1 2	1 2	1 3 2	1 5
7	3 6 3	3 8 2	1 [illegible] 2	1 2	1 3 3	1 5 2	1 7 1	1 9 1	1 1 1 3	1 1 2 2
8	1 2	1 4	1 6	1 8	1 1	1 1 2	1 1 4	1 1 6	1 1 8	1 2
9	1 7 1	1 9 2	1 1 1 3	1 1 4	1 1 6 1	1 1 8 2	1 1 3	1 1 3	1 2 5 1	1 2 7 3
10	1 1 2 2	1 1 5	1 7 2	1 2	1 3 3 2	1 3 5	1 3 7 2	1 3	1 3 2 3	1 5
11	1 1 7 3	1 2 2	1 2 3 1	1 2 6	1 3 8 3	1 3 1 2	1 3 4 1	1 1 7	1 3 3	2 1 2 2
12	1 2 3	1 2 6	1 2 9	1 3 1	1 3 5	1 3 8	2 1	2 4	2 1 7	2 1
13	1 2 8 2	1 3 1 3	1 3 4 3	1 3 8	2 1 1	2 4 2	2 7	2 1 1	2 1 4 1	2 1 7 2
14	1 3 3 3	1 3 7	2 2	2 4	2 7	8 1	2 1 4 2	2 1 8	2 2 1 2	2 2 5
15	1 3 8 3	2 2	2 6 2	2 1	2 1 3	2 1 7 2	2 2 1 1	2 2 5	2 2 8 3	2 3 2 2
16	2 4	2 8	2 2	2 6	2 2	2 2 4	2 2 8	2 3 2	2 3 5	3
17	2 9 1	2 3 3	2 7	2 2	2 1 6 1	2 3 2	2 3 4 3	2 3 9	3 3 1	3 7 2
18	2 1 4	2 9	2 3 2	2 2 8	2 3 2 8	2 3 7	3 1 2	3 6	3 1 2	3 1 5
19	2 1 9 3	2 1 4 2	2 2 4 1	2 3 4	2 3 8 3	3 3 2	3 8 1	3 1 3	3 1 7 1	3 2 2 2
20	3 2 5	2 3	2 3 5	3	3 5	3 1	3 1 5	3	3 2 5	3 3

This left side proceedes from 20. in the 5. Table.

In Table 6.

Table

Table 4.

This rowe proceedes in the 7. Table.

	31	32	33	34	35	36	37	38	39	40
1	0 0 7 3	0 0 3 0	0 0 8 1	0 0 8 2	0 0 8 3	0 0 7 0	0 0 9 1	0 0 9 2	0 0 9 3	0 1 0 0
2	0 1 3 4	1 6	1 6 2	1 7	1 7 2	1 8	1 8 2	1 9	1 9 2	2
3	1 3 1	2 4	2 4 3	2 5 2	2 6 1	0 2 7	0 2 7 3	2 8	2 9 1	3
4	3 1	3 2	3 3	3 4	3 5	0 3 6 0	3 7	3 3	3 9	1
5	3 8 3	1	1 1 1	1 2 3	1 3 3	1 5	1 6 1	1 7 2	1 8 3	1 1
6	1 1 6 2	1 8	1 9 2	1 1 1	1 2 2 2	1 1 4	1 1 5 2	1 1 7	1 1 8 2	1 2
7	1 1 4 1	1 1 6	1 1 7 3	1 1 9 2	1 2 1 1	1 2 3	1 2 4 3	1 2 6 2	1 2 8 1	1 3
8	1 2 2	1 2 4	1 2 6	1 2 8	1 3	1 3 2	1 3 4	1 3 6	1 3 8	2
9	1 2 9 3	1 3 2	1 3 4 1	1 3 6 2	1 3 8 3	2 1	2 3 1	2 5 2	2 7 3	2 1
10	1 3 7 3	2	2 2 2	2 5	2 7 2	2 1	2 1 2 2	2 1 5	2 1 7 2	2 2
11	2 5 1	2 8	2 1 3	2 1 3 2	2 1 6 1	2 1 9	2 2 1 3	2 2 4 2	2 2 7 1	2 3
12	2 1 3	2 1 6	2 1 9	2 2 2	2 2 5	2 2 8	2 3 1	2 3 4	2 3 7	3
13	2 2 3	2 2 4	2 2 7 1	2 3 2	2 3 8	2 3 7	3 1	3 3 2	3 6 3	3 1
14	2 2 8 2	2 3 2	2 3 5 2	2 3 9	3 2 2	3 6	3 9 2	3 1 3	3 1 6 2	3 2
15	2 3 6 1	3	3 3 3	3 7 2	3 1 1	3 5	3 1 8 3	3 2 2 2	3 2 6 1	3 3
16	3 4	3 8	3 1 2	3 1 6	3 2	3 2 4	3 2 8	3 3 2	4 3 6	4
17	3 1 1 3	3 1 6	3 2 1	3 2 4 2	3 2 8 3	3 3 3	3 3 7 1	4 1 2	4 5 3	4 1
18	3 1 9 2	3 2 4	3 2 8 2	3 3 3 2	3 3 7 2	4 2	4 6 2	4 1 1	4 1 5 2	4 2
19	3 2 7 1	3 3 2	3 3 6 3	4 1	4 6 1	4 1 1	4 1 5 3	4 2 2	4 2 5 1	4 3
20	3 3 1	4	4 5	4 1	4 1 5	4 2	4 2 5	4 3	4 3 5	5

This left ſide proceedes in the 6. Table.

In. Table 9.

Table 5.

This row proceedes in the 6: Table.

	21	22	23	24	25	26	27	28	29	30
21	3 3 1	2 3 5 2	3 3	3 6	3 1 1 1	3 1 6 2	3 2 1 3	3 2 7	3 3 2 1	3 3 7 2
	22	3 1	3 6 2	3 2 2	3 1 7 2	3 2 3	3 2 8 2	3 3 4	3 3 9 2	4 5
		23	3 1 2 2	3 1 8	3 2 3 8	3 2 9 2	3 3 5 1	4 1	4 1 6 3	4 1 2 2
			24	3 2 4	3 3	3 3 6	4 2	4 8	4 1 4	4 1
				25	3 3 4 1	4 2 2	4 8 2	4 1 5	4 2 1 1	4 2 7 2
					26	4 9	4 1 5 2	4 2 2	4 2 8 8	4 3 5
						27	4 2 2 1	4 2 9	4 3 5 1	5 2 2
							28	4 3 8	5 3	5 1
								29	5 1 1	5 1 7 2
									30	5 2 5

This proceedes in the 6 Table at 31, on the left ſide.

In Table 6.

Tabula

Table 6.

This rowe proceedes in the 9. Table.

	31	32	33	34	35	36	37	38	39	40
21	4 2 3	4 8	4 1 3 1	4 1 8 2	4 2 3 3	4 2 9	4 3 4 1	4 3 9 2	5 4 3	5 2
22	4 1 2	4 1 6	4 2 1 2	4 2 7	4 3 2 2	4 3 8	5 3 2	5 9	5 1 4 2	5 2
23	4 1 8 1	4 2 4	4 2 9 3	4 3 5 2	5 1 1	5 7	5 1 2 2	5 1 8 2	5 2 4 1	5 3
24	4 2 6	4 3 2	4 3 8	5 4	5 1	5 1 6	5 2 2	5 2 8	5 3 4	6
25	4 3 9 3	5	5 6 1	5 1 2 2	5 1 8 3	5 2 5	5 3 1 1	5 3 7 2	6 3 3	6 1
26	5 1 2	5 8	5 1 4 2	5 2 1	5 2 7 2	5 3 4	6 2	6 7	6 1 3 2	6 2
27	5 9 1	5 1 6	5 2 2 3	5 2 9 2	5 3 6 1	6 3	6 9 3	6 2 6 2	6 3 3 1	6 3
28	5 1 7	5 2 4	5 3 1	5 3 8	6 5	6 1 2	6 2 9	6 2 6	6 3 3	7
29	5 2 4 3	5 3 2	5 1 9 1	6 6 2	6 1 3 3	6 2 1	6 3 8 1	6 3 3 2	7 3 3	7 1
30	5 3 2 2	6	6 7 3	6 1 5	6 2 2 2	6 3	6 3 7 2	7 5	7 1 2 2	7 2
31	6 1	6 8	6 1 5 1	6 2 3 2	6 3 1 1	6 3 9	7 6 1	7 1 4 2	7 2 2 1	7 1
32		6 1 6	6 2 4	6 3 2	7	7 8	7 1 6	7 3 4	7 3 2	8
33			6 3 2 1	7 1	7 8 3	7 1 7	7 3 5 1	7 3 3 2	8 1 3	8 1
34				7 9	7 1 7 2	7 2 6	7 3 4 2	8 1	8 2 1 2	8 3
35					7 2 6 1	7 3 5	8 3 3	8 3 6 3	8 2 1 3	8 5
36						8 4	8 1 3	8 2 2	8 1 1	9 1
37							8 2 3 1	8 1 2 1	9 1	9 1
38								9 1	9 1 2	9 4
39									9 2 1	10
40										10

This left side proceeds in the 11. Tables

In Table 11.

Table 7.

This row proceedes in the 8 Table.

	41	42	43	44	45	46	47	48	49	50
1	1 1	1 2	1 3	1 1	1 1 1	3 1 3	1 1 3	1 2	1 2 1	1 2 2
2	2 2	2 1	2 1 2	2 2 1	2 2 2	2 3	2 3 2	2 4	2 4 2	2 5
3	3 3	3 1 2	3 2 1	3 3	3 3 3	3 4 2	3 5 3	3 6	3 6 3	3 7 2
4	1 1	1 2	1 3	1 4	1 5	1 6	1 7	1 8	1 9	1
5	1 1 1 1	1 1 2 2	1 1 2 3	1 1 5	1 1 6 1	1 1 7 2	1 1 8 3	1 2	1 2 1 1	1 2 2 2
6	1 2 1 2	1 2 3	1 2 4 2	1 2 6	1 2 7 2	1 2 9	1 3 2	1 3 2	1 3 3 2	1 3 5
7	1 3 1 3	1 3 3 2	1 3 5 1	1 3 7	1 3 8 3	2 2	2 2 1	2 4	2 5 3	2 7 2
8	2 2	2 4	2 6	2 8	2 3	2 1 2	2 1 4	2 1 6	2 1 8	2 2
9	2 1 2 1	2 1 4 2	2 1 6 3	2 1 9	2 2 1 1	2 2 1 2	2 2 5 3	2 2 8	2 3 1	2 3 2 2
10	2 2 2 2	2 2 5	2 2 7 2	2 3	2 3 2 2	2 3 5	2 3 7 2	3	3 8 2	3 5
11	2 3 2 3	3 3 5 2	2 3 3 1	3 1	3 3 3	3 6 2	3 9 1	3 1 4 3	3 1 7 2	3 1
12	3 3	3 6	3 9	3 1 2	3 1 5	3 1 8	3 2 1	3 2 4	3 2 7	3 3
13	3 1 3 1	3 1 6 2	3 1 9 3	3 2 3	3 2 6 1	3 2 9 2	3 3 2 3	3 3 6	3 3 9 1	4 2 2
14	3 2 3 2	3 2 7	3 3 2	3 3 4	3 3 7 2	4 1	4 4 2	4 8	4 1 1 2	4 1 5
15	3 2 3 3	3 3 7 2	4 1 1	4 5	4 8 3	4 1 2 2	4 1 5 1	4 2	4 2 3 3	4 3 7 3
16	4 4	4 8	4 1 2	4 1 6	4 2	4 2 4	4 2 8	4 3 2	4 3 6	5
17	4 1 4 1	4 1 8 2	4 2 2 3	4 2 7	4 3 1 1	4 3 5 2	4 3 9 3	5 4	5 3 1	3 2 2 1
18	4 2 4 2	4 2 9	4 3 3 2	4 3 8	5 2 2	5 7	5 1 1 2	5 1 6	5 2 2	5 2 5
19	4 3 4 3	4 3 9 2	5 4 1	5 9	5 1 3 3	5 1 8 2	5 2 3 1	5 2 8	5 3 2 3	5 3 7 2
20	5 5	5 1	5 1 5	5 2	5 2 5	5 3	5 3 5	6	6 5	6 3

This left ſide proceeds in the 9. Table:

In Table 10.

Table 8.

This rowe is continued in the 13. Table.

	51		52		53		54		55		56		57		58		59		60	
1	2	1 3	3	1	3	1 1	3	1 2	3	1 3	4	1	4	1 1	4	1 2	4	1 3	5	1
2	5	2 2	6	2	6	2 2	7	2	7	2 2	8	2	8	2 2	9	2	9	2 2		3
3	8	3 1	9	3	9	3 3	1	2	1 1	1	1 2		1 2	3	1 3	2	1 4	1	1 5	
4	1 1	1	1 2	1	1 3	1	1 4	1	1 5	1	1 6	1	1 7	1	1 8	1	1 9	1	1	2
5	1 3	2 3	1 5	2	1 6	2 1	1 7	2 2	1 8	2 3	1	3	1 1	3 1	1 1	3 2	1 3	3 3	1 5	3
6	1 6	3 2	1 8	3	1 9	3 2	2 1		2 2	2	2 4		2 5	2	2 7		2 8	2	2	1
7	2 9	1	2 1	1	2 2	1 3	2 4	1 2	2 6	1 1	2 8	1	2 9	1 3	2 1	2 2	2 2	2 1	2 5	2
8	2 2	2	2 4	2	2 6	2	2 8	2	2	3	2 3	3	2 4	3	2 6	3	2 8	3	3	
9	2 4	5 3	2 7	3	2 9	3 1	3 1	2	3 3	3	3 6		3 8	1	3	1 2	3 2	1 3	3 5	1
10	3 7	2	8	1	3 2	1 2	3 5	1	3 7	1 2	3	2	3 2	2 2	3 5	2 2	3 7	2 3	3	3
11	3 9	1 1	3 3	2	3 3	2 3	3 8	2 2	3 1	3 1	3 4	3	3 6	3 3	3 9	3 2	4 2	1	4 5	
12	3 3	3	3 6	3	3 9	3	4 2		4 5		4 8		4 1	1	4 4	1	4 7	1	4	3
13	4 5	3	4 9		4 2	1 1	4 5	1 2	4 8	1 3	4 1	2	4 5	2 1	4 8	2 2	4 1	3 3	4 5	3
14	4 8	1 2	4 2	2	4 5	2 2	4 9	2	4 2	3 2	4 6	3	4 9	3 2	5 3		5 6	2	5	1
15	4 1	3 1	4 5	3	4 8	3 3	5 2	2	5 6	1	5	1	5 3	1 3	5 7	1 2	5 1	2 1	5 5	2
16	5 4	1	5 8		9 2	1	5 6	1	5	2	5 4	2	5 8	2	5 2	3	5 6	3	6	
17	5 6	1 3	5 1	2	5 4	2 1	5 3	2 3	5 9	2 3	5 3	3 3	5 8	3	6 6	2	6	1 3	6 5	1
18	5 9	2 2	5 4	3	5 8	3 2	6		6 7	2	6 3	1	6 6	1 2	6 1	2	6 5	3 2	6	3
19	6 2	1	6 7		6 1	1 2	6 6	1 2	6 1	2 1	6 6	2	6	3 3	6 3	3 2	7	1	7 5	
20	6 5	1	6	2	6 5	2	6	3	6 5	3	7		7		7	1	7 5	1	7	2

This lefte ſide proceedes in the 20 Table.

In Table 15.

Table 9.

This rowe is continued in the 10 Table.

	41	42	43	44	45	46	47	48	49	50
21	5 1 5 1	5 2 2	5 2 5 3	5 3 1	5 3 6 1	6 1 2	6 6 3	6 1 2	6 1 7 1	6 2 2 2
22	5 2 3 2	5 3 1	5 3 6 2	6 2	6 7 2	6 1 3	6 1 8 2	6 2 1	6 2 9 2	6 3 5
23	5 3 5 3	6 1 2	6 7 1	6 1 3	6 1 8 3	6 2 4 2	6 3 1	6 3 6	7 1 3	7 7 2
24	6 6	6 1 2	6 1 8	6 2 4	6 3	6 3 6	7 2	7 8	7 1 4	7 2
25	6 1 6 1	6 2 2 2	6 2 8 3	6 3 5	7 1 1	7 7 2	7 1 3 3	7 2	7 2 6 1	7 3 2 3
26	6 2 6 2	6 3 3	6 3 9 2	7 6	7 1 2 2	7 1 9	7 2 5 2	7 3 2	7 3 8 2	8 5
27	6 3 6 3	7 3 2	7 1 1	7 1 7	7 2 3 3	7 3 2	7 3 7 1	8 4	8 1 3	8 1 7 2
28	7 7	7 1 4	7 2 1	7 2 8	7 3 5	8 2	8 9	8 1 6	8 2 3	8 3
29	7 1 7 1	7 2 4 2	7 3 1 3	7 3 9	8 6 1	8 1 3 2	8 2 3	8 2 8	8 3 5 1	9 2 2
30	7 2 7 2	7 3 5	8 2 2	8 1	8 1 1 2	8 2 5 2	8 3 2 2	9	9 7 2	9 1 5
31	7 3 7 3	8 5 2	8 1 3 1	8 2 1	8 2 8 2	8 3 6 2	9 4 1	9 1 2	9 1 9 3	9 2 7 2
32	8 8	8 1 6	8 2 4	8 3 2	9	9 8	9 1 6	9 2 4	9 3 2	10
33	8 1 8 1	8 2 6 2	8 3 4 3	9 3	9 1 1 1	9 1 9 2	9 2 7 3	9 3 6	10 4 1	10 1 2 2
34	8 2 8 2	8 3 7	9 5 2	9 1 4	9 2 2 2	9 3 1	9 3 9 2	10 8	10 1 6 2	10 2 5
35	8 3 8 3	9 7 2	9 1 6 1	9 2 5	9 3 3 3	10 2 2	10 1 1 1	10 2	10 2 8 3	10 3 7 3
36	9 9	9 1 8	9 2 7	9 3 6	10 5	10 1 4	10 2 3	10 3 2	11 1	11 1
37	9 1 9 1	9 2 8 2	9 3 7 3	10 7	10 1 6 1	10 2 5 2	10 3 4 3	11 4	11 1 3 1	11 2 2 2
38	9 2 9 2	9 3 9	10 8 2	10 1 8	10 2 7 2	10 3 7	11 6 2	11 1 6	11 2 5 2	11 3 5
39	9 3 9 3	10 2	10 1 9 1	10 2 9	10 3 8 3	11 8 2	11 1 8 1	11 2 8	11 3 7 2	12 7 1
40	10 1	10 2	10	11	11 1	11 2	11 3	12	12 1	12 2

This left ſide proceedes in the 11 Table.

In Table 12.

Table

Table 10.

This rowe is continued in the 15. Table.

	51	52	53	54	55	56	57	58	59	60
21	6 2 7 3	6 3 3	6 3 8 1	7 3 2	7 8 3	7 1 4	7 1 9 1	7 2 4 2	7 2 9 3	7 3 5
22	7 2	7 6	7 1 1 2	7 1 7	7 2 2 2	7 2 8	7 3 3 2	7 3 9	8 4 2	8 1
23	7 1 3 1	7 1 9	7 2 4 3	7 3 2	7 3 6 2	8 2	8 7 3	8 1 3 2	8 2 9 1	8 2 5
24	7 2 6	7 3 2	7 3 8	8 4	8 1	8 1 6	8 2 2	8 2 8	8 3 4	9
25	7 3 8 3	8 5	8 1 1 1	8 1 7 3	8 2 3 3	8 3	8 3 6 1	9 2 2	9 8 3	9 1 5
26	8 1 1 2	8 1 8	8 2 4 2	8 3 1	8 3 7 2	9 4	9 1 2	9 1 7	9 2 3 2	9 3
27	8 2 4 1	8 3 1	8 3 3 3	9 4 2	9 1 1 1	9 1 8	9 2 4 3	9 3 1 2	9 3 8 1	10 5
28	8 3 7	9 1	9 1 1	9 1 8	9 2 5	9 3 2	9 3 9	10 9	10 1 3	10 2
29	9 9 3	9 1 7	9 2 4 1	9 3 1 2	9 3 8 3	10 6	10 1 3 1	10 2 2	10 2 7 3	10 3 5
30	9 2 2 2	9 3	9 3 7 2	10 5	10 1 2 2	10 2	10 2 7 2	10 3 5	11 2 1	11 1
31	9 3 5 1	10 3	10 1 3	10 1 8 2	10 2 6 1	10 3 4	11 1	11 9 2	11 1 7 1	11 2 5
32	10 8	10 1 6	10 2 4	10 3 2	11	11 8	11 1 6	11 2 4	11 3 2	12
33	10 2 3	10 2 9	10 3 7 1	11 5 2	11 1 3 3	11 2 2	11 3 1	11 3 8 2	12 6 3	12 1 5
34	10 3 3 2	11 2	11 1 2	11 1 9	11 2 8 2	11 3 6	12 4 2	12 1 3	12 2 1 2	12 3
35	11 6 1	11 1 5	11 2 3 3	11 3 2 2	12 1 1	12 1	12 1 8 3	12 2 7 2	12 3 6 1	13 5
36	11 1 9	11 2 8	11 3 7	12 6	12 1 5	12 2 4	12 3 3	13 2	13 1 1	13 2
37	11 3 1 3	12 1	12 1 1	12 1 9 2	12 2 8 3	12 3 8	13 7 1	13 1 6 2	13 2 5 3	13 8 5
38	12 4 2	12 1 4	12 2 3 2	12 3 3	13 2 2	13 1 2	13 2 1 2	13 3 1	14 2	14 1
39	12 1 7 1	12 2 7	12 3 6 3	13 6 2	13 1 6 1	13 2 6	13 3 3 3	14 5 2	14 1 5 1	14 2 5
40	12 3	13	13 1	13 2	13 3	14	14 1	14 2	14 3	15

This lefte ſide proceedes in the 12 Table.

In Table 17.

Table 11.

This row is continued in the 12 Table.

	41	42	43	44	45	46	47	48	49	50
41	10 2 1	10 3 3	11 3	11 1 1	11 2 1 1	11 3 1 2	12 1 3	12 1 2	12 2 2 1	12 3 2 2
	42	11 1	11 1 1 2	11 2 2	11 3 2 2	12 3	12 1 3 2	12 2 4	12 3 4 2	13 5
		43	11 2 2 1	11 3 3	12 2 3	12 1 4 2	12 2 4 1	12 2 5 1	12 3 6	13 1 7 2
			44	12 4	12 1 5	12 2 6	12 3 7	13 8	13 1 9	13 2
				45	12 2 6 1	12 3 7 2	13 8 3	13 2	13 5 1 1	14 2 2
					46	13 9	13 2 2	13 3 2	14 3 2	14 1 5
						47	13 3 2 1	14 4	14 1 5 3	14 2 7 2
							48	14 1 6	14 2 8	15
								49	15 1	15 1 2 2
									50	15 2 5

This left ſide proceedes in the 12 Table.

In Table 12.

Table 12.

This rowe is continued in the 17 Table.

	51		52		53		54		55		56		57		58		59		60	
41	13 2	 3	13 3	1	13 3	2 1	13 3	3 2	14 3	 3	14 4	1	14 4	2 1	14 4	3 2	15 4	 3	15 5	1
42	13 5	1 2	13 6	2	13 6	3 2	14 7		14 7	1 2	14 8	2	14 8	3 2	15 9		15 9	1 2	15	3
43	13 8	2 1	13 9	3	14 9	 3	14	2 2	14 1	3 1	15 2		15 2	1 3	15 3	2 2	15 4	3 1	16 5	
44	14 1		14 2	1	14 3	2	14 4	3	15 5		15 6	1	15 7	2	15 8	3	16 9		16	2
45	14 3	1 3	14 5	2	14 6	3 1	15 7	 2	15 8	1 3	15	3	16 1	 1	16 2	1 2	16 3	2 3	16 5	3
46	14 6	2 2	14 8	3	15 9	 2	15 1	2	15 2	3 2	16 14		16 5	1 2	16 7	2	16 8	3 2	17	1
47	14 4	3 1	15 1	1	15 2	2 3	15 4	3 2	16 6	 1	16 8	1	16 9	2 3	17 1	 2	17 3	1 1	17 5	2
48	15 2	1	15 4	2	15 6	3	16 8		16	2	16 2	3	17 4		17 6	1	17 8	2	18	
49	15 4	2 3	15 7	3	16 9	 1	16 1	2 2	16 3	3 3	17 6		17 8	1 1	17	3 2	18 2	 3	18 5	1
50	15 7	3 2	16	1	16 2	2 2	16 5	3	17 7	 2	17	2	17 2	3 2	18 5		18 7	1 2	18	3
51	16	1 1	16 3	2	16 5	3 3	17 8	 2	17 1	2 1	17 4	3	18 6	 3	18 9	1 2	18 2	3 1	19 5	
52			16 6	3	17 9		17 2	2	17 5	3	18 8		18 1	2	18 4	3	19 7		19	2
53					17 2	2 1	17 5	3 2	18 8	 3	18 2	2	18 5	3 1	19 8	 2	19 1	2 3	19 5	3
54							18 9		18 2	2 2	18 6	3	19 4	 2	19 3	2	19 6	3 2	20	1
55									18 6	3 1	19	1	19 3	2 3	19 7	2 2	20 1	1 1	20	2
56											15 4	2	19 8	3	20 2	1	20 6	2	2	1
57													20 2	1 1	20 6	2	21	 1	21 5	1
58															21 1		21 5	 2	21	3
59																	21	3 1	22 5	5
60																			22	2

This left ſide proceedes in the 19 Table.

In Table 19.

Table 11.

This row is continued in the 12 Table.

	41		42		43		44		45		46		47		48		49		50	
41	10	2 1	10	3 2	11	 3	11 1	1	11 1	2 1	11 1	3 2	12 1	 3	12 2	1	12 2	2 1	12 2	3 2
			42																	
					11 1		11 1	1 2	11 2	2	11 2	3 2	12 3		12 3	1 2	12 4	2	12 4	3 2
					43															
							11 2	2 1	11 3	3	12 2	 3	12 4	1 2	12 4	2 1	12 5	2 1	12 6	3
							44													

	43		44		45		46		47		48		49		50	
43	11 2	2 1	11 3	3	12 2	 3	12 4	1 2	12 4	2 1	12 5	2 1	12 6	3	13 7	1 2
44			12 4		12 5	1	12 6	2	12 7	3	13 8		13 9	1	13	3
45					12 6	2 1	12 7	3 2	13 8	 3	13	2	13 1	5 1	14 2	 2
46							13 9		13	2 2	13 2	3	14 3	 2	14 5	1
47									13 2	3 1	14 4		14 5	1 2	14 7	2 2
48											14 6	1	14 8	2	15	
49													15	 1	15 2	1 2
50															15 5	2

This left ſide proceedes in the 12 Table.

In Table 12.

Table 12.

This rowe is continued in the 17 Table.

	51	52	53	54	55	56	57	58	59	60
41	13 2 3	13 1 3	13 2 3 1	13 3 3 2	14 3 3	14 1 4	14 2 4 1	14 3 4 2	15 4 3	15 1 5
42	13 1 5 2	13 2 6	13 3 6 2	14 7	14 1 7 2	14 2 8	14 3 8 2	15 9	15 1 9 2	15 3
43	13 2 8 1	13 3 9	14 9 3	14 2 2	14 3 1 1	15 2	15 1 2 3	15 2 3 2	15 3 4 1	16 5
44	14 1	14 1 2	14 2 3	14 3 4	15 5	15 1 6	15 2 7	15 3 8	16 9	16 2
45	14 1 3 3	14 2 5	14 3 6 1	15 7 2	15 1 8 3	15 3	16 1 1	16 1 2 2	16 2 3 3	16 3 5
46	14 2 6 2	14 3 8	15 9 2	15 2 1	15 3 2 2	16 14	16 1 5 2	16 2 7	16 3 8 2	17 1
47	14 3 4 1	15 1 1	15 2 2 3	15 3 4 2	16 6 1	16 1 8	16 2 9 3	17 1 2	17 1 3 1	17 2 5
48	15 1 2	15 2 4	15 3 6	16 8	16 2	16 3 2	17 4	17 1 6	17 2 8	18
49	15 2 4 3	15 3 7	16 9 1	16 2 1 2	16 3 3 3	17 6	17 1 8 1	17 3 2	18 2 3	18 1 5
50	15 3 7 2	16 1	16 2 2 2	16 3 5	17 7 2	17 2	17 3 2 2	18 5	18 1 7 2	18 3
51	16 1 1	16 2 3	16 3 5 3	17 8 2	17 2 1 1	17 3 4	18 6 3	18 1 9 2	18 3 2 1	19 5
		52	16 3 6	17 9	17 2 2	17 3 5	18 8	18 2 1	18 3 4	19 7	19 2
			53	17 2 2 1	17 3 5 2	18 8 3	18 2 2	18 3 5 1	19 8 2	19 2 1 3	19 3 5
				54	18 9	18 2 2 2	18 3 6	19 4 2	19 2 3	19 3 6 2	20 1
					55	18 3 6 1	19 1	19 2 3 3	19 2 7 2	20 1 1 1	20 2
						56	15 2 4	19 3 8	20 1 2	20 2 6	2 1
							57	20 1 2 2	20 2 6	21 1	21 1 5
								58	21 1	21 5 2	21 3
									59	21 3 1	22 5 5
										60	22 2

This left ſide proceedes in the 19 Table.

In Table 19.

Table 13.

This row is continued in the 14. Table.

		61	62	63	64	65	66	67	68	69	70
1	5	1 1|5	1 2|5	1 3|6	1|6	1 1|6	1 2|6	1 3|7	1|7	1 1|7	1 2
2		3 2|1	3|1	3 2|2	3|2	3 2|3	3|3	3 2|4	3|4	3 2|5	3
3	1 5	3|1 6	2|1 7	1|1 8	|1 8	3|1 9	2|1	1 1|1 1	1|1 1	1 3|1 2	1 2
4	1 1	2|1 2	3|1 3	2|1 4	3|1 5	2|1 6	2|1 7	2|1 8	2|1 9	2|1	3
5	1 6	3 1|1 7	3 2|1 8	3 3|2	|2 1	1|2 2	2|2 3	3|2 5	|2 6	1|2 7	2
6	2 1	1 2|2 3	1|2 4	1 2|2 6	1|2 7	1 2|2 9	1|2	2 2|2 2	2|2 8	2 2|2 5	2
7	2 6	2 3|2 8	2 2|2	3 1|2 2	3|2 3	3 3|2 5	3 2|2 7	3 1|2 9	3|3	3|3 2	2
8	3 2	|3 4	|3 6	|3 8	|3	1|3 2	1|3 4	1|3 6	1|3 8	1|3	2
9	3 7	1 1|3 9	1 2|3 1	2 3|3 4	2|3 6	2 1|3 8	2 2|3	3 3|3 3	3|3 5	3 1|3 7	3 2
10	3 2	3 2|3 5	3|3 7	3 2|4	|4 2	2|4 5	|4 7	2|4	1|4 2	1 2|4 5	1
11	4 7	3|4	1 2|4 3	1 1|4 6	1|4 8	1 3|4 1	2 2|4 4	2 1|4 7	2|4 9	2 3|4 2	3 2
12	4 3	2|4 6	2|4 9	2|4 2	3|4 5	3|4 8	3|5 1	|5 4	|5 7	|5	1
13	4 8	3 1|5 1	2|5 4	3|5 8	|5 1	1 1|5 4	1 2|5 7	1 3|5 1	2|5 4	3 1|5 7	2 2
14	5 3	1 2|5 7	1|5	2 2|5 4	2|5 7	2 2|5 1	3|5 4	3 2|5 8	3|6 1	2|6 5	
15	5 8	2 3|5 2	3 2|5 6	3 1|6	|6 2	3|6 7	2|6 1	1 1|6 5	1|6 8	1 3|6 2	2 2
16	6 4	|6 8	|6 2	1|6 6	1|6	2|6 4	2|6 8	2|6 2	3|6 6	3|7	
17	6 9	1 1|6 3	2 2|6 7	2 3|6 2	3|6 6	3 1|7	2|7 4	3|7 9	|7 3	1 1|7 7	1 2
18	6 4	3 2|6 9	3|7 2	3|7 8	|7 2	1 2|7 7	1|7 1	2 2|2 6	2|7	3 2|7 5	3
19	7 9	3|7 4	1 2|7 9	1 1|7 4	2|7 8	2 3|7 3	3 2|7 8	3 1|8 3	|8 7	3|8 2	1 2
20	7 5	2|7	3|7 5	3|8	|8 5	|8	1|8 5	1|8 1	2|8 5	2|8	3

This left ſide proceedes in the 15 Table.

In Table 6.

Table 14.

This rowe is continued no longer.

	71	72	73	74	75	76	77	78	79	80	
1	$\vert 7$	${}^{1}_{3}\vert 8$	${}^{1}\vert 8$	${}^{1}_{1}\vert 8$	${}^{1}_{2}\vert 8$	${}^{1}_{3}\vert 9$	${}^{1}\vert 9$	${}^{1}_{1}\vert 9$	${}^{1}_{2}\vert 9$	${}^{1}_{3}\vert$	2
2	5	${}^{3}_{2}\vert 6$	${}^{3}\vert 6$	${}^{3}_{2}\vert 7$	${}^{3}\vert 7$	${}^{3}_{2}\vert 8$	${}^{3}\vert 8$	${}^{3}_{2}\vert 9$	${}^{3}\vert 9$	${}^{3}_{2}\vert{}^{1}$	
3	${}^{1}_{1}$	${}^{1}_{1}\vert{}^{1}_{4}$	${}^{1}\vert{}^{1}_{4}$	${}^{1}_{3}\vert{}^{1}_{5}$	${}^{1}_{2}\vert{}^{1}_{6}$	${}^{1}_{1}\vert{}^{1}_{7}$	${}^{1}\vert{}^{1}_{7}$	${}^{1}_{3}\vert{}^{1}_{8}$	${}^{1}_{2}\vert{}^{1}_{9}$	${}^{1}_{1}\vert{}^{1}$	2
4	${}^{1}_{1}$	${}^{3}\vert{}^{1}_{2}$	${}^{3}\vert{}^{1}_{3}$	${}^{3}\vert{}^{1}_{4}$	${}^{3}\vert{}^{1}_{5}$	${}^{3}\vert{}^{1}_{6}$	${}^{3}\vert{}^{1}_{7}$	${}^{3}\vert{}^{1}_{8}$	${}^{3}\vert{}^{1}_{9}$	${}^{3}\vert{}^{2}$	
5	${}^{2}_{8}$	${}_{3}\vert{}^{2}$	${}^{1}\vert{}^{2}_{1}$	${}^{1}_{1}\vert{}^{2}_{2}$	${}^{1}_{2}\vert{}^{2}_{3}$	${}^{1}_{3}\vert{}^{2}_{5}$	${}^{1}\vert{}^{2}_{6}$	${}^{1}_{1}\vert{}^{2}_{7}$	${}^{1}_{2}\vert{}^{2}_{8}$	${}^{1}_{3}\vert{}^{2}$	2
6	${}^{2}_{6}$	${}^{2}_{2}\vert{}^{2}_{8}$	${}^{2}\vert{}^{2}_{9}$	${}^{2}_{2}\vert{}^{2}_{1}$	${}^{3}\vert{}^{2}_{2}$	${}^{3}_{2}\vert{}^{2}_{4}$	${}^{3}\vert{}^{2}_{5}$	${}^{3}_{2}\vert{}^{2}_{7}$	${}^{3}\vert{}^{2}_{8}$	${}^{3}_{3}\vert{}^{3}$	
7	${}^{3}_{4}$	${}_{1}\vert{}^{3}_{6}$	$\vert{}^{3}_{7}$	${}^{1}_{3}\vert{}^{3}_{9}$	${}_{2}\vert{}^{3}_{1}$	${}^{1}_{1}\vert{}^{3}_{3}$	${}^{1}\vert{}^{3}_{4}$	${}^{1}_{3}\vert{}^{3}_{6}$	${}^{1}_{2}\vert{}^{3}_{8}$	${}^{1}_{1}\vert{}^{3}$	2
8	${}^{3}_{2}$	${}^{2}\vert{}^{3}_{4}$	${}^{2}\vert{}^{3}_{6}$	${}^{2}\vert{}^{3}_{8}$	${}^{2}\vert{}^{3}$	${}^{3}\vert{}^{3}_{2}$	${}^{3}\vert{}^{3}_{4}$	${}^{3}\vert{}^{3}_{6}$	${}^{3}\vert{}^{3}_{8}$	${}^{3}\vert{}^{4}$	
9	${}^{3}_{9}$	${}^{3}_{3}\vert{}^{4}_{2}$	$\vert{}^{4}_{4}$	${}_{1}\vert{}^{4}_{6}$	${}_{2}\vert{}^{4}_{8}$	${}_{3}\vert{}^{4}$	${}^{1}\vert{}^{4}_{3}$	${}^{1}_{1}\vert{}^{4}_{5}$	${}^{1}_{2}\vert{}^{4}_{7}$	${}^{1}_{2}\vert{}^{4}$	2
10	${}^{4}_{7}$	${}^{1}_{2}\vert{}^{4}$	${}^{2}\vert{}^{4}_{2}$	$\vert{}^{4}_{2}$	${}^{2}_{2}\vert{}^{4}_{5}$	${}^{2}\vert{}^{4}_{7}$	${}^{2}_{2}\vert{}^{4}$	${}^{3}\vert{}^{4}_{2}$	${}^{3}_{2}\vert{}^{4}_{5}$	${}^{3}_{2}\vert{}^{5}$	
11	${}^{4}_{5}$	${}^{3}_{3}\vert{}^{4}_{8}$	${}^{3}_{2}\vert{}^{5}$	${}_{3}\vert{}^{5}_{3}$	${}_{2}\vert{}^{5}_{6}$	${}_{1}\vert{}^{5}_{9}$	$\vert{}^{5}_{1}$	${}^{1}_{3}\vert{}^{5}_{4}$	${}^{1}_{2}\vert{}^{5}_{7}$	${}^{1}_{1}\vert{}^{5}$	2
12	${}^{5}_{3}$	${}^{1}\vert{}^{5}_{6}$	${}^{1}\vert{}^{5}_{9}$	${}^{1}_{1}\vert{}^{5}_{2}$	${}^{2}\vert{}^{5}_{5}$	${}^{2}\vert{}^{5}_{8}$	${}^{2}\vert{}^{5}_{1}$	${}^{3}\vert{}^{5}_{4}$	${}^{3}\vert{}^{5}_{7}$	${}^{3}\vert{}^{6}$	
13	5	${}^{3}_{3}\vert{}^{5}_{4}$	${}^{3}\vert{}^{5}_{7}$	${}^{3}_{1}\vert{}^{6}$	${}_{2}\vert{}^{6}_{3}$	${}_{3}\vert{}^{6}_{7}$	$\vert{}^{6}$	${}^{1}_{1}\vert{}^{6}_{3}$	${}^{1}_{2}\vert{}^{6}_{6}$	${}^{1}_{3}\vert{}^{6}$	2
14	${}^{6}_{8}$	${}_{2}\vert{}^{6}_{2}$	${}^{1}\vert{}^{6}_{5}$	${}^{1}_{2}\vert{}^{6}_{9}$	${}^{1}\vert{}^{6}_{2}$	${}^{2}_{2}\vert{}^{6}_{6}$	${}^{2}\vert{}^{6}_{9}$	${}^{2}_{2}\vert{}^{6}_{3}$	${}^{3}\vert{}^{6}_{6}$	${}^{3}_{2}\vert{}^{7}$	
15	${}^{6}_{6}$	${}^{2}_{1}\vert{}^{6}$	${}^{2}\vert{}^{6}_{3}$	${}^{3}_{3}\vert{}^{6}_{7}$	${}^{3}_{2}\vert{}^{7}_{1}$	${}_{1}\vert{}^{7}_{5}$	$\vert{}^{7}_{8}$	${}_{3}\vert{}^{7}_{2}$	${}^{1}_{2}\vert{}^{7}_{6}$	${}^{1}_{1}\vert{}^{7}$	2
16	${}^{7}_{4}$	$\vert{}^{7}_{8}$	$\vert{}^{7}_{2}$	${}^{1}\vert{}^{7}_{6}$	${}^{1}\vert{}^{7}$	${}^{2}\vert{}^{7}_{4}$	${}^{2}\vert{}^{7}_{8}$	${}^{2}\vert{}^{7}_{2}$	${}^{3}\vert{}^{7}_{6}$	${}^{3}\vert{}^{8}$	
17	${}^{7}_{1}$	${}^{2}_{3}\vert{}^{7}_{6}$	${}^{2}\vert{}^{7}$	${}^{3}_{3}\vert{}^{7}_{4}$	${}^{3}_{2}\vert{}^{7}_{8}$	${}^{3}_{3}\vert{}^{8}_{3}$	$\vert{}^{8}_{7}$	${}_{1}\vert{}^{8}_{1}$	${}^{1}_{2}\vert{}^{8}_{5}$	${}^{1}_{3}\vert{}^{8}$	2
18	${}^{7}_{9}$	${}^{3}_{2}\vert{}_{4}$	$\vert{}^{8}_{8}$	${}_{1}\vert{}^{8}_{3}$	${}^{1}\vert{}^{8}_{7}$	${}^{1}_{2}\vert{}^{8}_{2}$	${}^{2}\vert{}^{8}_{6}$	${}^{2}_{2}\vert{}^{8}_{1}$	${}^{3}\vert{}^{8}_{5}$	${}^{3}_{2}\vert{}^{9}$	
19	${}^{8}_{7}$	${}^{1}_{1}\vert{}^{8}_{2}$	${}^{2}\vert{}^{8}_{6}$	${}^{2}_{3}\vert{}^{8}_{1}$	${}^{3}_{2}\vert{}^{8}_{6}$	${}^{3}_{1}\vert{}^{9}_{1}$	${}^{1}\vert{}^{9}_{5}$	${}_{3}\vert{}^{9}$	${}^{1}_{2}\vert{}^{9}_{5}$	${}^{1}_{1}\vert{}^{9}$	2
20	${}^{8}_{5}$	${}^{3}\vert{}^{9}$	$\vert{}^{9}_{5}$	$\vert{}^{9}$	${}^{1}\vert{}^{9}_{5}$	${}^{1}\vert{}^{9}$	${}^{2}\vert{}^{9}_{5}$	${}^{2}\vert{}^{9}$	${}^{3}\vert{}^{9}_{5}$	${}^{3}\vert{}^{10}$	

This left ſide proceedes in the 16 Table.

Table 15.

This row is continued in the 6. Table.

	61	62	63	64	65	66	67	68	69	70
21	8 1	8 5 2	8 1 3	8 1 6	8 2 1 1	8 2 6 3	8 3 1 3	8 3 7	9 2 1	9 7 2
22	8 1 5 2	8 2 1	8 2 6 2	8 3 2	8 3 7 2	9 3	9 8 2	9 1 4	9 1 9 2	9 2 5
23	8 3 3	8 3 6 2	9 2 1	9 8	9 1 3 3	9 1 9 2	9 2 5 1	9 3 1	9 3 6 3	10 2 2
24	9 6	9 1 2	9 1 8	9 2 4	9 3	9 3 6	10 2	10 8	10 1 4	10 2
25	9 2 1 2	9 2 7 2	9 3 3 3	10	10 6 1	10 1 2 2	10 1 8 3	10 2 5	10 3 1 1	10 3 7 2
26	9 3 6 2	10 3	10 9 2	10 1 6	10 2 2 2	10 2 9	10 3 5 2	11 2	11 8 2	11 1 5
27	10 1 1 3	10 1 8 2	10 2 5 1	10 3 2	10 3 8 3	11 5 2	11 1 2 1	11 1 9	11 2 5 3	11 3 2 2
28	10 2 7	10 3 4	11 1	11 8	11 1 5	11 2 2	11 2 9	11 3 6	12 3	12 1
29	11 2 1	11 9 2	11 1 6 3	11 2 4	11 3 1 1	11 3 8 2	12 5 3	12 1 3	12 2 1	12 2 7 2
30	11 1 7 2	11 2 5	11 3 2 3	12	12 7 2	12 1 5	12 2 2 2	12 3	12 3 7 2	13 5
31	11 3 2 3	12 2	12 8 1	12 1 6	12 2 3 3	12 3 1 2	12 3 9 1	13 7	13 1 4 3	13 2 2 2
32	12 8	12 1 6	12 2 4	12 3 2	13	13 8	13 1 6	13 2 4	13 3 2	14
33	12 2 3 1	12 3 1 2	12 3 9 3	13 8	13 1 6 1	13 2 4 2	13 3 2 3	14 1	14 9 1	14 1 7 8
34	12 3 8 3	13 7	13 1 5 2	13 2 4	13 3 2 2	14 1	14 9 2	14 1 8	14 2 6 2	14 3 5
35	13 1 7 3	13 2 2 2	13 3 1 1	14	14 8 3	14 1 7 2	14 2 6 1	14 3 5	15 3 3	15 1 2 2
36	13 2 9	13 3 8	14 7	14 1 6	14 2 5	14 3 4	15 3	15 1 2	15 2 1	15 3
37	14 4 1	14 1 3 2	14 2 2 3	14 3 2	15 1 1	15 1 2	15 1 9 3	15 2 9	15 3 8 1	16 7 2
38	14 9 2	14 2 9	14 3 8 2	15 8	15 1 7 2	15 2 7	15 3 6 2	16 6	16 1 5 2	16 2 5
39	14 3 4 3	15 4 2	15 1 4 3	15 2 4	15 3 3 3	16 3 2	16 1 3 1	16 2 3	16 3 2 3	17 2 2
40	15 1	15 2	15 3	16	16 1	16 2	16 3	17	17 1	17 2

This Table proceedes in the 17 Table.

In Table 18.

This rowe is continued no further.

Table 16.

○	71	72	73	74	75	76	77	78	79	80
21	9 1 2 3	9 1 3	9 2 3 1	9 2 8 2	9 3 3 3	9 3 9	10 4 1	10 9 2	10 1 4 3	10 2
22	9 3 2	9 3 6	10 2 2	10 7	10 1 2 2	10 1 3	10 1 3 2	10 9	10 3 4	11 1
23	10 1 8 1	10 1 4	10 1 9 3	10 2 5 2	10 3 2 1	10 3 7	11 2 3	11 8 2	11 1 4 1	11 2
24	10 2 6	10 2 2	10 3 8	11 4	11 1	11 1 6	11 2 2	11 3 3	11 3 4	12 1
25	11 9 3	11 1	11 1 6	11 2 2 2	11 2 8 3	11 3 3	12 1 1	12 2 2	12 1 3	12 2 3
26	12 2 1 2	12 2 8	12 3 4	12 2	12 7 2	12 1 6	12 1	12 2 7 2	12 3 8	13 2
27	12 3 9 1	12 6	12 1 2 3	12 1 9	12 2 6 1	12 3 3	13 9 3	13 6 2	13 1 3	13 2 1
28	12 2	13 2 4	13 3 2	13 3 8	13 5	13 1 2	13 1 9	13 3 6	13 3 3	14 1
29	13 3 4 3	13 2	13 9 1	13 1 6 2	13 2 3 3	13 3 2	13 3 8 1	14 5 2	14 3 2	14 2 3
30	13 3 2 2	13 2 1	13 2 7 2	13 3 5	14 2 2	14 1	14 1 7 2	14 2 5	14 3 2	15 2
31	13 3 1	13 3 8	14 5 3	14 1 3 2	14 2 1	14 2 9	14 3 0 3	15 4 2	15 2 2 1	15 2
32	14 3	14 2 6	14 2 4	14 3 2	15	15 8	15 1 6	15 2 4	15 3 2	16
33	14 3 5 3	14 3 4	15 2 1	15 1	15 1 8 3	15 2 7	15 3 5 1	16 2 2	16 1 1	16 2
34	15 2	15 1 2	15 2 1 2	15 2 9	15 3 7 2	16 5	16 1 4 1	16 2 2 1	16 3 1 2	17
35	15 2 1	15 3	15 3 8	16 1 2	15 1 6 1	16 2 1	17 3 1	17 2 1	17 2	17 2
36	15 3 3	8	16 1 7	16 2 6	16 3 5	17 4	17 1 3	17 2 2	17 3 1	18
37	16 1 6 3	16 2 6	16 5 2	17 4 2	17 1 3 3	17 2 8	17 3 2 1	18 2	18 3 1	18 2
38	16 3 2	17 2	17 1 3 2	17 2 3	17 3 2 2	18 3	18 2 2	18 2	18 3 1	19
39	17 1 2 1	17 2 2	17 3 2	18 2	18 1 2 2	18 2 2	18 3 3	19 2	19 1 2	19 2
40	17 3	18	18 1	18 2 1	18 3	19	19 1	19 2	19 3	20

This Table proceeds in the 18 Table.

No contin uance of both sides any further.

Table 17.

This rowe is continued in the 18. Table.

	61	62	63	64	65	66	67	68	69	70
41	15 2 5 1	15 3 5 2	16 5 3	16 1 6	16 3 6 1	16 3 6 2	17 6 3	17 1 7	17 2 7 3	17 3 7 2
42	16 2	16 1 1	16 2 1 2	16 3 2	17 2 2	17 1 3	17 2 3 2	17 3 4	18 4 2	18 1 5
43	16 1 5 3	16 3 6 2	16 3 7 1	17 8	17 1 8 3	17 2 9 2	18 1	18 1 1	18 2 1 3	18 3 2 2
44	16 3 1	17 2	17 1 3	17 2 4	17 3 5	18 6	18 1 7	18 2 8	18 3 9	19 1
45	17 6 1	17 1 7 2	17 2 8 3	18	18 1 1 1	18 2 2 2	18 3 3 3	19 5	19 1 6 2	19 2 7 3
46	17 2 1 3	17 3 3	18 4 2	18 1 6	18 2 7 2	18 3 9	19 1 2	19 2 2	19 3 5 3	20 5
47	17 3 6 3	18 8 1	18 2 1	18 3 2	19 3 3	19 1 5 2	19 2 7 1	19 3 9	20 1 3	20 2 2 2
48	18 1 2	18 2 4	18 3 6	19 8	19 2	19 3 2	20 4	20 1 6	20 2 8	21
49	18 2 7 1	19 9 3	19 1 1 3	19 2 4	19 3 6 1	20 8 2	20 2 3	20 3 3	21 5 1	21 1 7 2
50	19 2 2	19 1 5	19 2 7 2	20	20 1 2 2	20 2 5	20 3 7 2	21 1	21 2 2	21 3 5
51	19 1 7 3	19 3 2	20 3 1	20 1 6	20 2 8 3	21 1 2	21 1 4 1	22 1 7	21 3 7 3	22 1 2 2
52	19 3 3	20 6	20 1 9	20 3 2	21 5	21 1 8	21 3 1	22 4	22 1 7	22 3
53	20 8 1	20 2 1 2	20 3 4 3	21 8	21 2 1 1	21 3 4 2	22 7 3	22 2 1	22 3 4 1	23 7 2
54	20 2 2 2	20 3 7	21 2	21 2 4	22 1 7 2	22 1 1	22 2 4 2	22 2 8	23 1 1 2	23 2 5
55	20 3 8 3	21 1 2 3	21 3 6 1	22	22 1 1 3	22 3 7 3	23 2 1	23 1 5	23 2 8 3	24 3 2
56	21 1 4	21 1 8	22 2	22 1 6	22 3	23 4	23 1 8	23 8	24 6	24 2
57	21 2 9 1	22 3 2	22 1 7 3	22 3 2	23 6 1	23 2 2	23 3 4 3	24 8 9	24 2 2 1	24 3 7 2
58	22 4 2	22 1 9	22 3 3 2	23 8	23 3 2 2	23 3 7	24 1 1 2	24 2 8	25 3	25 1 5
59	22 1 9 3	22 3 4 2	23 9 2	23 2 4	23 1 8 3	24 1 2 2	24 2 8 1	25 3	25 1 7 2	25 3 2 2
60	22 3 5	23 1	23 2 5	24	24 1 5	24 3	25 5	25 2	25 3 5	26 2

This Table proceedes in the 20 Table.

In Table vii.

Table 18.

No further Continuance.

	71	72	73	74	75	76	77	78	79	80
41	18 7	18 3 8	1 18 8	2 18 1 8	3 19 2 8	19 3 9	1 19 9	2 19 1 9	3 20 2 9	20 2 3
42	18 5	2 18 2 6	3 19 6	19 1 7	1 19 7	2 19 2 8	3 20 8	30 2 9	1 20 9	2 21 1
43	19 3	19 1 4	1 19 4	2 19 3 5	3 20 2 6	20 1 7	1 20 7	2 20 3 8	3 21 2 9	21 2 1
44	19 1	2 19 2	3 20 3	20 4	1 20 5	2 20 6	3 21 7	21 8	1 21 9	2 22
45	19 8	3 20 3	1 20 1	2 20 1 2	3 21 2 3	21 3 5	1 21 6	2 21 1 7	3 22 2 8	22 2 3
46	20 6	1 20 3 8	2 20 9	3 21 2 1	1 21 2	2 22 2 4	3 22 5	22 2 7	1 22 8	2 23 3
47	20 9	3 21 1 6	21 7	1 21 3 9	2 22 2 1	22 1 3	1 22 4	2 22 3 6	3 23 2 8	23 2 1
48	21 2	1 21 4	2 21 6	3 22 8	22	2 22 2	3 23 4	23 6	1 23 8	2 24
49	21 9	2 22 3 2	22 4	1 22 1 6	2 22 2 8	3 23 3 1	1 23 3	2 23 1 5	3 24 2 7	24 2 3
50	22 7	22 2	2 22 2	3 23 2 5	23 7	1 23 2	3 24 2	24 2 5	1 24 7	2 25 2
51	22 5	2 22 1 8	3 23	1 23 3 3	2 23 2 6	3 24 1 9	24 1	2 24 3 4	3 25 2 7	25 2 1
52	23 3	23 6	1 23 9	2 24 2	24 5	1 24 8	1 25 1	25 4	1 25 7	2 26
53	23	2 23 3 4	3 24 7	24 1	2 24 2 3	3 25 3 7	25	2 25 2 3	3 26 2 6	26 2 3
54	23 8	3 24 1 2	1 24 5	2 24 2 9	3 25 2 1	1 25 2 6	2 25 9	3 26 2 3	1 26 6	2 27 2
55	24 6	1 24 1	3 25 3	25 3 7	1 25 2 1	3 26 1 5	26 8	1 26 2 2	3 27 2 6	27 2 1
56	24 4	3 25 8	25 2	2 25 6	3 26	1 26 4	2 26 8	3 27 2	1 27 6	2 28
57	25 1	1 25 3 6	2 26	26 1 4	1 26 2 9	2 27 3 3	27 7	1 27 1 1	3 28 2 5	28 2 1
58	25 9	2 26 2 4	26 8	1 26 2 3	3 27 7	27 2 2	2 27 6	3 28 2 1	1 28 9	2 29 2
59	26 7	26 1 2	2 26 6	3 27 3 1	1 27 2 6	2 28 1 1	28 5	1 28 2	3 29 2 5	29 2 1
60	26 5	2 27	27 5	1 27	3 28 5	28	2 28 5	3 29 1	1 29 5	2 30

This left ſide proceeds in the 20 Table.

No further continuance of both ſides.

Table 19.

This row is continued in the 10 Table.

	61	62	63	64	65	66	67	68	69	70
61	23 1 1	23 2 5 2	24 3	24 1 6	24 3 1 1	25 6 2	25 2 1 3	25 3 7	26 1 2 1	26 2 7 2
	62	24 1	24 1 6 2	24 3 2	25 7 2	25 2 3	25 3 8 2	26 1 4	26 2 9 2	27 5
		63	24 3 2 1	25 8	25 2 1 3	25 3 9 2	26 1 5 1	26 3 1	27 6 3	27 2 2 2
			64	25 2 4	26	26 1 6	26 3 2	27 8	27 2 4	28
				65	26 1 6 1	26 3 2 2	27 8 3	27 2 5	28 1 1	28 1 7 2
					66	27 9	27 2 5 2	28 2	28 1 8 2	28 3 5
						67	28 2 1	28 1 0	28 3 5 3	29 1 2 2
							68	28 3 6	29 1 3	29 3
								69	29 3 1	30 7 2
									70	30 2 5

This left ſide proceedes in the 20 Table.

In Table vlt.

Table 20.

	71	72	73	74	75	76	77	78	79	80
61	27 2 3	27 1 8	27 3 3 1	28 8 2	28 2 3 3	28 3 9	29 1 4 1	29 2 9 2	30 4 3	30 2
62	27 2 2	27 3 6	28 1 1	28 2 7	29 2 3	29 1 8	29 3 8 2	30 9	31 2 6 2	31
63	27 3 8 1	28 1 4	28 2 4 3	29 5 2	29 2 1 1	29 3 7	30 1 1 3	30 2 8 2	31 4 1	31 2
64	28 1 6	28 3 8	29 8	29 2 4	30	30 1 6	30 3 2	31 3	31 2 4	32
65	28 3 3 3	29 1	29 2 6 1	30 2 2	30 1 8 3	30 3 5	31 1 1 1	31 2 7 2	32 3 2	32 2
66	29 1 1 2	29 2 8	30 4 2	30 2 1	30 3 7 2	31 4	31 3 2	32 7	32 2 3 2	33
67	29 2 9 1	30 6	30 2 7 3	30 3 4 2	31 1 6 1	31 3 2	32 9 3	32 2 6 2	33 1 1	33 2
68	30 7	30 2 4	31 1	31 1 8	31 3 5	32 1 2	32 2 9	33 6	33 2 2	34
69	30 2 4 3	31 2	30 1 9 1	31 3 6 2	32 1 3 3	32 3 1	33 8 1	33 2 5 2	34 2 3	34 2
70	31 2 2	31 2	32 3 7 2	32 1 5	32 3 2 2	33 1	33 3 7 2	34 5	34 2 2 2	35
71	31 1	31 3 8	32 1 5 3	32 3 3 2	33 1 1 1	33 2 9	34 6 3	34 2 4 2	35 2 1	35 2
72		32 1 6	32 3 4	33 1 2	33 3	34 8	34 2 6	35 4	35 2 2	36
73			33 1 2 1	33 3 3	34 8 3	34 2 7 2	35 5 1	35 2 8 2	36 1 3	36 2
74				34 8	34 2 7 2	35 6	35 2 4 2	36 3	36 1 2	37
75					35 6 1	35 2 5	36 3 3	36 2 1	37 1 1	37 2
76						36 4	36 2 1	37 2	37 2 1	38
77							37 2 1	37 2 1 2	38 2	38 2
78								38 1	38 2 1	39
79									39 1	39 2
80										40

The Table ends here,

Chap. XXVIII.

How to worke when there be parts of Pearches adioyned to the whole.

IT often falleth out that you ſhall haue parts of Pearches adioyned vnto the whole, the quantity of which you ſhall finde in the inſuing Table, which I haue calculated with eaſie Demonſtrations, becauſe the Vulgar ſort cannot vnderſtand what is meant by a Pearch when he is expreſt by a fraction And for becauſe you can hardly (or not at all) make a ſenſible difference betwixt the quarter & halfe quarter vpon your ſcale (as I haue ſaid before) therfore I haue calculated my Table by the quarter, halfe, and 3 quarters, the vſe whereof is thus

Conſider whether the partes be wanting in the length, in the breadth, or in both: If they bee wanting in length, enter this table with the breadth, finding the ſame in the row vpon the left hand in one of the 2. tables vnder the title Pearch, proceeding from 1 to 80: hauing found the breadth, in the ſaid ſide, conſider whether the odde parts be a quarter, a halfe, or 3 quarters of a pearch, and then procede right-wards vntill you come vnder the ſame, and there ſhal you ſee expreſſed the number of Day-workes, pearches, yards, and as the odde parts reſult vnto,

Example.

I Haue a peece of ground whoſe one ſide is 29 perches, and the other 40 pearches and a halfe: I finde 29 in the firſt to be in the row vpon the left hand, and then procede right-wardes vntyll I come vnder the title of halfe pearches; anſwering to which do I ſee 3 day-workes, 2 pearches, 2 yeards, 2 foote and 3 inches, which muſt be added vnto the former contents of 40, and 29. found in the other table of whole pearches.

If the parts had bene annext to 29, then muſt you haue entred the table with 40, which was the other ſide, and ſo of any other; the table is playne of himſelfe.

Now if the parts had wanted both in length and in bredth, you muſt firſt haue worked as if they were od in the breadth, and note that downe: & then worke as it were the length, and what you finde in the table, adde to that you found noted downe before, which you muſt adde to the whole pearch found in the other table.

Chap. XXIX.

A Tryangle peece of ground giuen, in the one ſide whereof is

A perfect Table of the F
with eaſie denominati
tute made by *Ed.*

Quarters of Pearches.						Halfe pearche				
hes.	orke.	ch.	de.	te.	ch.	worke.	arch.	arde.	oote.	nch.

a
roûd
oynt

ny
res
o
aid.

A perfect Table of the Fractions, or parts of Integer Pearches: newly calculated, with eaſie denominations for the exact meaſuring of all Land, according to the Statute made by *Ed.* 1. *Anno*. 33. entituled *Compoſitio vlnarum & perditarum.*

	Quarters of Pearches.					Halfe pearches					Three quarters of the Pearch.				
Pearches.	Day-worke.	Pearch.	Yarde.	Foote.	Inch.	Day-worke.	Pearch.	Yarde.	Foote.	Inch.	Day-worke.	Pearch.	Yarde.	Foote	Inch.
1	0	0	1	1	1.	0	0	2	2	3	0	0	4	0	4:
2	0	0	2	2	3	0	1	0	0	0	0	1	2	2	3
3	0	0	4	0	4:		1	2	2	3		2	1	1	1:
4	0	1	0	0	0	0	2	0	0	0		3	0	0	0
5	0	1	1	1	1.		2	2	2	3	3	3	4		4.
6	0	1	2	2	3		3	0	0	0		0	2	2	3
7	0	1	4	0	4:		3	2	2	3	3	1	1	1	1:
8	0	2	0	0	0	1	0	0	0	0	0	2	0	0	0
9	0	2	1	1	1.	1	0	2	2	3	1	2	4	0	4
10	0	2	2	2	3	1	1				1	3	2	2	4
11		2	4	0	4:	1	1	2	2	3	2	0	1	1	1
12		3	0	0	0	1	2	0	0	0	2	1	0	0	0
13		3	1	1	1:	1	2	2	2	3	2	1	4	0	4:
14		3	2	2	3	1	3	0	0	0	2	2	2	2	3
15		3	4	0	4:	1	3	2	2	3	2	3	1	1	1:
16	1	0	0	0	0	2	0	0	0	0	3	0	0	0	0
17	1	0	1	1	1.	2	0	2	2	3	3	0	4	0	4:
18	1		2	2	3	2	1	0	0	0	3	1	2	2	3
19	1		4		4:	2	1	2	2	3	3	2	1	1	1.
20	1	1	0	0	0	2	2	0	0	0	3	3	0	0	0
21	1	1	1	1	1:	2	2	2	2	3	3	3	4		4:
22	1	1	2	2	3	2	3	0			4		2	2	3
23	1	1	4		4	2	3	2	2	3	4	1	1	1	1:
24	1	2				3					4	2	0	0	
25	1	2	1	1	1	3	1	2	2	3	4	2	4	0	4:
26	1	2	2	2	3	3	1				4	3	2	2	3
27	1	2	4		4:	3	2	2	2	3	5		1	1	1:
28	1	3				3	2				5	1			
29	1	3	1	1	1:	3	2	2	2	3	5	1	4		4:
30	1	3	2	2	3	3	3				5	2	2	2	3
31	1	3	4		4:	3	3	2	2	3	5	3	1	1	1:
32	2					4					6				
33	2		1	1	1:	4		2	2	3	6		4		4:
34	2		2	2	3	4	1				6	1	2	2	3
35	2		4		4:	4	1	2	2	3	6	2	1	1	1:
36	2	1				4	2				6	3			
37	2	1	1	1	1:	4	2	2	2	3	6	3	4		4:
38	2	1	2	2	3	4	3				6	4	2	2	3.
39	2	1	4		4:	4	3	2	2	3	7	1	1	1	1:
40	2	2	0	0	0	5	0	0	0	0	7	2			

	The quarter of Pearches.					Halfe pearches					Three quarters of Pearch.					
Pearches.	Day-worke.	Pearch.	Yard.	Foote.	Inch.	Day-worke.	Pearch.	Yarde.	Foote.	Inch.	Day worke.	Pearch.	Yarde.	Foote.	Inch.	
41	2	2	1	1	1:	5		2	2	3	7	2	4	0	4:	
42	2	2	2	2	3	5	1				7	3	2	2	3	
43	2	2	4		4:	5	1	2	2	3	8		1	1	1:	
44	2	3				5	2				8	1				
45	2	3	1	1	1:	5	2	2	2	3	8	1	4		4:	
46	2	3	2	2	3	5	3				8	2	2	2	3	
47	2	3	4		4:	5	3	2	2	3	8	3	1	1	1:	
48	3					6					9					
49	3		1	1	1:	6	0	2	2	3	9		4		4:	
50	3		2	2	3	6	1				9	1	2	2	3	
51	3		4		4:	6	1	2	2	3	9	2	1	1	1:	
52	3	1				6	2				9	3				
53	3	1	1	1	1:	6	2	2	2	3	9	3	4	0	4:	
54	3	1	2	2	3	6	3				1		0	2	2	3
55	3	1	4	0	4:	6	3	2	2	3	1		1	1	1	1:
56	3	2				7					1		2			
57	3	2	1	1	1:	7		2	2	3	1		2	4		4:
58	3	2	2	2	3	7	1				1		3	2	2	3
59	3	2	4		4:	7	1	2	2	3	1	1	0	1	1	1:
60	3	3				7	2				1	1	1			
61	3	3	1	1	1:	7	2	2	2	3	1	1	1	4		4:
62	3	3	2	2	3	7	3				1	1	2	2	2	3.
63	3	3	4		4:	7	3	2	2	3	1	1	3			
64	4					8					1	2				
55	4		1	1	1:	8		2	2	3	1	2		4		4:
66	4		2	2	3	8	1				1	2	1	2	2	3:
67	4	0	4		4:	8	1	2	2	3	1	2	2	1	1	1:
68	4	1				8	2				1	2	3			
69	4	1	1	1	1:	8	2	2	2	3	1	2	3	4		4:
70	4	1	2	2	3	8	3				1	3		2	2	3
71	4	1	4		4:	8	3	2	2	3	1	3	1	1	1	1:
72	4	2				9	0				1	3	2			
73	4	2	1	1	1:	9	0	2	2	3	1	3	2	4	0	4:
74	4	2	2	1	3	9	1				1	3	3	2	2	3
75	4	2	4		4:	9	1	2	2	3	1	4	0	1	1	1:
76	4	3				9	2				1	4	1			
77	4	3	1	1	1:	9	2	2	2	3	1	4	1	4		4:
78	4	3	2	2	3	9	3				1	4	2	2	2	3
79	4	3	4		4:	9	3	2	2	3	Roode.	Day-worke.	Pearch.	Yard.	Foote.	Inch.
80	5	0	0	0	0	A iuſt Roode.										

Here the denominatiõs change to thoſe in the foot of the table.

Vnder the title of Inch, one pricke ſtandes for a quarter, & two pricks for halfe an Inch

For partes wanting in {length / breadth} enter this Table with the {breadth / length} of your peece of ground | Parts wanting in {breadth and length} worke firſt as it were the length, then as it were the breadth of the ground, & that as reſulteth of both adde together.

3. Barley cornes is an Inch, 12. Inches a Foote, 3. Foote a Yard, 5. Yards and a halfe a Pearch, 4. Pearch a day-worke, 10. dayworke a Roode, 4. Roode an Acher.

Place this Table betweene folio 194. and 195.

Chap. XXVIII.

How to worke when there be parts of Pearches adioyned to

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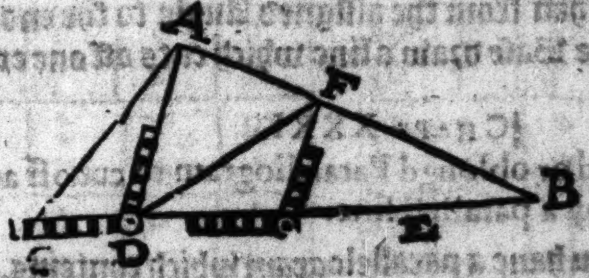
Chap. XXIX.

A Tryangle peece of ground giuen, in the one ſide whereof is a Well placed, this peece of ground is to be equally deuided betwixt two men, in ſuch ſort that both parties may haue benefite thereof: my queſtion is, how it ſhall be performed.

To deuide a peece of groũd from any poynt aſsigned.

Let the Peece of ground like a Tryangle be A B C: let the Well be at D, then I deuide that ſide C B into 2 equall partes at E, next I place my Staffe at the Well D, and take the angle C D A, keeping that angle vnaltred I place againe my ſtaffe at E, the midſt of the ſide the Well ſtandeth in, making the left legge as it was before ly Parallell vnto the ſide C B, then I note vnto what place of the ſide A B the fiduciall edge of the right legge pointeth as to F. and there I make a marke: for a Hedge made from D to F, deuides the Tryangle as it was propoſed.



Chap. XXX.

A Triangular peece of ground aſſigned, to cut off any number of Acres, roodes, &c. as ſhall be required, and that by a Hedge drawne from any angle aſſigned.

To cut off any number of acres in any ſquare peece of groũd.

You ſhall firſt conſider from what Angle the Hedge ſhall be drawne, and then what ſide ſubtendeth the ſaid angle, which ſide you ſhal meaſure, and then meaſure the whole Area of the Tryangle: then ſhall you conſider how many Acres, Roodes &c. you would cut off, which multiply by the length of the Baſe or Line ſubtending the former Angle, the Product whereof deuide by the whole Area of the Triangle: the Quotient ingendred thereof declares vnto you how many perches you ſhall meaſure in the Baſe from any one of the Angles to cut off the number of Rodes deſired.

Example.

LEt the 3 ſides of the Tryangle be 30, 40, 50, Perches, my deſire is with a right line from the angle ſubtended by 50 the greateſt ſide, to cut of one acre off ground: to performe this firſt I ſeeke the Area of the triangle, as is taught before, which is 600 Rodes, now becauſe I would cut off from the Figure one Acre, which is 160 Rodes, I multiply 160 by 50, the whole ſide ſubtending the ſaid Angle, the product being. 8000, I deuide by the Area of the Tryangle. 600, the Quotient is $13\frac{1}{3}$, ſo many Perches I reckon in the Baſe from ſome of the corners, and then from the aſſigned Angle to the ende of your meaſure, in the Baſe draw a line which cuts off one exact Acre.

Chap. XXXI.

In a rectangled or oblongd Parallelogram, to cut off any quan- aſſigned by a parallell line.

ADmit you haue a parallelogram which conteins. 65 acres, 16 perches, & that with a parallele to one of the endes, I would cut off 5 acres: firſt therefore by ſome Rules before publiſhed, find ye length of one of ye longer parallele ſides which let be 308 rode; thē I multiply 308 by 800, for ſo many rods are there in 5 Acres the whole Area, which yeldeth. 246400, which deuide by. 10456. the number of perches cōteined in the whole area, which yeeldeth in ye Quotient. 23. perches 11. foote, and ſo much muſt you meaſure frō the end in both ye longer parallele ſides, & where that number ends, in each ſide make two markes direct, frō one of which vnto ye other draw a line which ſhal cut of iuſt 5 acres: & this rule is general for al quadrangle peeces of ground whoſe ſides & ends be parallell, be the figure a Rombus, an oblong &c. other wayes you may find (which I omit) to ſeparat other regulare figures, & the rather becauſe there ſhal a Table of purpoſe inſue, and may be performed Inſtrumentally alſo.

And heere note when you haue any peece of ground how irregular ſoeuer or of what regular faſhion ſoeuer, as circle, &c. you may reduce ye ſame in to a ſquare or ſuch like figure as is * taught, & ſo ſpeedely meaſure the ſame, or deuide it into what kinde or how many partes you wil, as you be taught in the Cap. 30, 31, 32, 33, of this Booke.

The

The Table whereby to ſeparate or incloſe one Statute acre of land by it ſelfe.

Firſt ſide.	The ſecond ſide.				Firſt ſide.	The ſecond ſide.			
	pearches.	parts.	feete	inch.		pearches.	parts.	feete.	inch.
1	160	0	0	0	25	6	$\frac{1}{4}$	2	5:
2	80	0	0	0	26	6	0	2	6:
3	53	$\frac{1}{4}$	1	4.	27	5	$\frac{3}{4}$	2	10:
4	40	0	0	0	28	5	$\frac{1}{2}$	3	6:
5	32	0	0	0	29	5	$\frac{1}{2}$	0	3:
6	26	$\frac{1}{2}$	2	9	30	5	$\frac{1}{4}$	1	4.
7	22	$\frac{3}{4}$	1	9:	31	5	0	2	7:
8	20	0	0	0	32	5	0	0	0
9	17	$\frac{3}{4}$	0	6.	33	4	$\frac{3}{4}$	1	7.
10	16	0	0	0	34	4	$\frac{1}{2}$	3	4:
11	14	$\frac{1}{2}$	0	9	35	4	$\frac{1}{2}$	1	2:
12	13	$\frac{1}{4}$	1	5.	36	4	$\frac{1}{4}$	3	2:
13	12	$\frac{1}{4}$	0	11:	37	4	$\frac{1}{4}$	1	2:
14	11	$\frac{1}{4}$	2	11:	38	4	0	3	5:
15	10	$\frac{1}{2}$	2	9	39	4	0	1	8:
16	10	0	0	0	40	4	0	0	0
17	9	$\frac{1}{4}$	2	8:	41	3	$\frac{3}{4}$	2	6:
18	8	$\frac{3}{4}$	2	3.	42	3	$\frac{3}{4}$	0	11:
19	8	$\frac{1}{4}$	2	9:	43	3	$\frac{1}{2}$	3	7:
20	8	0	0	0	44	3	$\frac{1}{2}$	2	3.
21	7	$\frac{1}{2}$	1	11:	45	3	$\frac{1}{2}$	0	11
22	7	$\frac{1}{4}$	0	4.	46	3	$\frac{1}{4}$	3	9:
23	6	$\frac{3}{4}$	3	4:	47	3	$\frac{1}{4}$	2	6:
24	6	$\frac{1}{2}$	2	9	48	3	$\frac{1}{4}$	1	4:

The Table for one Acre.

Firſt ſide.	The ſecond ſide.			
	pear-ches.	parts.	feete.	inch.
49	3	$\frac{1}{4}$	0	3:
50	3	0	3	3:
51	3	0	2	3:
52	3	0	1	3:
53	3	0	0	3:
54	2	$\frac{3}{4}$	3	6:
55	2	$\frac{3}{4}$	2	7:
56	2	$\frac{3}{4}$	1	9:
57	2	$\frac{3}{4}$	0	9:
58	2	$\frac{3}{4}$	0	1:
59	2	$\frac{1}{2}$	3	5:
60	2	$\frac{1}{2}$	2	9
61	2	$\frac{1}{2}$	2	0:
62	2	$\frac{1}{2}$	1	3:
63	2	$\frac{1}{2}$	0	7:
64	2	$\frac{1}{2}$	0	0:
65	2	$\frac{1}{4}$	3	5:
66	2	$\frac{1}{4}$	2	10
67	2	$\frac{1}{4}$	2	3:
68	2	$\frac{1}{4}$	1	8:
69	2	$\frac{1}{4}$	1	1:
70	2	$\frac{1}{4}$	0	7:
71	2	$\frac{1}{4}$	0	0
72	2	$\frac{1}{4}$	3	8

Firſt ſide.	Second ſide.			
	pear-ches.	part.	feete.	Inch.
73	2	0	3	1
74	2	0	2	5
75	2	0	2	2
76	2	0	1	5
77	2	0	1	3
78	2	0	0	10
79	2	0	0	5
80	2	0	0	0
81	1	$\frac{3}{4}$	3	8
82	1	$\frac{3}{4}$	3	3
83	1	$\frac{3}{4}$	2	11
84	1	$\frac{3}{4}$	2	6
85	1	$\frac{3}{4}$	2	2
86	1	$\frac{3}{4}$	1	9
87	1	$\frac{3}{4}$	1	5
88	1	$\frac{3}{4}$	1	1
89	1	$\frac{3}{4}$	0	9
90	1	$\frac{3}{4}$	0	5
91	1	$\frac{3}{4}$	0	1
92	1	$\frac{1}{2}$	3	11
93	1	$\frac{1}{2}$	3	7
94	1	$\frac{1}{2}$	3	4
95	1	$\frac{1}{2}$	3	0
96	1	$\frac{1}{2}$	2	9

The Table for one Acre of ground.

Firſt ſide.	The ſecond ſide:				Firſt ſide.	The ſecond ſide			
	pearches.	parts.	feete	inch.		pearches.	parts.	feete.	inch.
97	1	1/2	2	5	121	1	1/4	1	2
98	1	1/2	2	2	122	1	1/4	1	0
99	1	1/2	1	11	123	1	1/4	0	10
100	1	1/2	1	7	124	1	1/4	0	7
101	1	1/2	1	4	125	1	1/4	0	5
102	1	1/2	1	1	126	1	1/4	0	3
103	1	1/2	0	10	127	1	1/4	0	1
104	1	1/2	0	4	128	1	1/4	0	0
105	1	1/2	0	4	129	1	0	3	11
106	1	1/2	0	1	130	1	0	3	9
107	1	1/4	4	1	131	1	0	3	7
108	1	1/4	3	9	132	1	0	3	6
109	1	1/4	3	7	133	1	0	3	4
110	1	1/4	3	4	134	1	0	3	2
111	1	1/4	3	2	135	1	0	3	0
112	1	1/4	2	11	136	1	0	2	10
113	1	1/4	2	9	137	1	0	2	9
114	1	1/4	2	6	138	1	0	2	7
115	1	1/4	2	3	139	1	0	2	5
116	1	1/4	2	1	140	1	0	2	5
117	1	1/4	1	11	141	1	0	2	2
118	1	1/4	1	8	142	1	0	2	1
119	1	1/4	1	6	143	1	0	1	11
120	1	1/4	1	4	144	1	0	1	10

The Table for one Acre.

First ſide.	The ſecond ſide.			
	pearches.	parts.	feete.	inch.
49	3	1/4	0	3:
50	3	0	3	3:
51	3	0	2	3:
52	3	0	1	3:
53	3	0	0	3:
54	2	3/4	3	6:
55	2	3/4	2	7:
56	2	3/4	1	9:
57	2	3/4	0	9:
58	2	3/4	0	1:
59	2	1/2	3	5:
60	2	1/2	2	9
61	2	1/2	2	0:
62	2	1/2	1	3:
63	2	1/2	0	7:
64	2	1/2	0	0:
65	2	1/4	3	5:
66	2	1/4	2	10
67	2	1/4	2	3:
68	2	1/4	1	8:
69	2	1/4	1	1:
70	2	1/4	0	7:
71	2	1/4	0	0
72	2	1/4	3	8

First ſide.	Second ſide.			
	pearches.	part.	feete.	Inch.
73	2	0	3	1
74	2	0	2	5
75	2	0	2	2
76	2	0	1	5
77	2	0	1	3
78	2	0	0	10
79	2	0	0	5
80	2	0	0	0
81	1	3/4	3	8
82	1	3/4	3	3
83	1	3/4	2	11
84	1	3/4	2	6
85	1	3/4	2	2
86	1	3/4	1	9
87	1	3/4	1	5
88	1	3/4	1	1
89	1	3/4	0	9
90	1	3/4	0	5
91	1	3/4	0	1
92	1	1/2	3	11
93	1	1/2	3	7
94	1	1/2	3	4
95	1	1/2	3	0
96	1	1/2	2	9

The

The Table for one Acre of ground.

First ſide.	The ſecond ſide.				First ſide.	The ſecond ſide.			
	pearches.	parts.	feete	inch.		pearches.	parts.	feete.	inch.
97	1	$\frac{1}{2}$	2	5	121	1	$\frac{1}{4}$	1	2
98	1	$\frac{1}{2}$	2	2	122	1	$\frac{1}{4}$	1	0
99	1	$\frac{1}{2}$	1	11	123	1	$\frac{1}{4}$	0	10
100	1	$\frac{1}{2}$	1	7	124	1	$\frac{1}{4}$	0	7
101	1	$\frac{1}{2}$	1	4	125	1	$\frac{1}{4}$	0	5
102	1	$\frac{1}{2}$	1	1	126	1	$\frac{1}{4}$	0	3
103	1	$\frac{1}{2}$	0	10	127	1	$\frac{1}{4}$	0	1
104	1	$\frac{1}{2}$	0	4	128	1	$\frac{1}{4}$	0	0
105	1	$\frac{1}{2}$	0	4	129	1	0	3	11
106	1	$\frac{1}{2}$	0	1	130	1	0	3	9
107	1	$\frac{1}{4}$	4	1	131	1	0	3	7
108	1	$\frac{1}{4}$	3	9	132	1	0	3	6
109	1	$\frac{1}{4}$	3	7	133	1	0	3	4
110	1	$\frac{1}{4}$	3	4	134	1	0	3	2
111	1	$\frac{1}{4}$	3	2	135	1	0	3	0
112	1	$\frac{1}{4}$	2	11	136	1	0	2	10
113	1	$\frac{1}{4}$	2	8	137	1	0	2	9
114	1	$\frac{1}{4}$	2	6	138	1	0	2	7
115	1	$\frac{1}{4}$	2	3	139	1	0	2	5
116	1	$\frac{1}{4}$	2	1	140	1	0	2	5
117	1	$\frac{1}{4}$	1	11	141	1	0	2	2
118	1	$\frac{1}{4}$	1	8	142	1	0	2	1
119	1	$\frac{1}{4}$	1	6	143	1	0	1	11
120	1	$\frac{1}{4}$	1	4	144	1	0	1	10

One Acre.

firſt ſide.	Second ſide. pearches.	parts.	feete	inch
145	1	0	1	8
146	1	0	1	6
147	1	0	1	5
148	1	0	1	4
149	1	0	1	2
150	1	0	1	1
151	1	0	0	11
152	1	0	0	10
153	1	0	0	9
154	1	0	0	7
155	1	0	0	6
156	1	0	0	5
157	1	0	0	3
158	1	0	0	2
159	1	0	0	1
160	1	0	0	0

The end of the firſt Table calculated for one acre of ground.

Two Acres.

firſt ſide.	Second ſide. pearches	parts.	feete.	inch.
1	320	0	0	0
2	160	0	0	0
3	106	½	2	9
4	80	0	0	0
5	64	0	0	0
6	53	¼	1	4
7	45	½	3	6
8	40	0	0	0
9	35	½	0	11
10	32	0	0	0
11	29	0	1	6
12	26	½	2	9
13	24	½	1	10
14	22	¾	1	9
15	21	¼	1	4
16	20	0	0	0
17	18	¾	1	2
18	17	¾	0	5
19	16	¾	1	6
20	16	0	0	0
21	15	0	3	11
22	14	½	0	9
23	13	¾	2	8
24	13	¼	1	4

The Table for two Acres.

First side.	The second side.			
	pearches.	parts.	feete.	inch.
25	12	$\frac{3}{4}$	0	9
26	12	$\frac{1}{4}$	0	11
27	11	$\frac{1}{4}$	1	8
28	11	$\frac{1}{2}$	2	0
29	11	0	0	6
30	10	$\frac{1}{2}$	2	9
31	10	$\frac{1}{4}$	1	2
32	10	0	0	0
33	9	$\frac{1}{2}$	3	3
34	9	$\frac{1}{4}$	2	8
35	9	0	2	4
36	8	$\frac{3}{4}$	2	3
37	8	$\frac{1}{2}$	2	5
38	8	$\frac{1}{4}$	2	0
39	8	0	3	4
40	8	0	0	0
41	7	$\frac{3}{4}$	0	1
42	7	$\frac{1}{2}$	1	11
43	7	$\frac{1}{4}$	3	1
44	7	$\frac{1}{4}$	0	4
45	7	0	1	10
46	6	$\frac{3}{4}$	3	4
77	6	$\frac{3}{4}$	0	11
78	6	$\frac{1}{2}$	2	9

First side.	Second side.			
	pearches.	parts.	feete.	Inch.
49	6	$\frac{1}{2}$	0	6
50	6	$\frac{1}{4}$	2	5
51	6	$\frac{1}{4}$	0	4
52	6	0	2	6
53	6	0	0	7
54	5	$\frac{3}{4}$	2	10
55	5	$\frac{1}{4}$	1	1
56	5	$\frac{1}{2}$	3	6
57	5	$\frac{1}{2}$	1	10
58	5	$\frac{1}{2}$	0	3
59	5	$\frac{1}{4}$	2	10
60	5	$\frac{1}{4}$	1	4
61	5	0	4	0
62	5	0	2	7
63	5	0	1	3
64	5	0	0	0
65	4	$\frac{3}{4}$	2	10
66	4	$\frac{3}{4}$	1	7
67	4	$\frac{3}{4}$	0	5
68	4	$\frac{1}{2}$	3	4
69	4	$\frac{1}{2}$	2	3
70	4	$\frac{1}{2}$	1	2
71	4	$\frac{1}{2}$	0	1
72	4	$\frac{1}{4}$	3	2

One Acre.

first ſide.	Second ſide.			
	pearches.	parts.	feete	inch
145	1	0	1	8
146	1	0	1	6
147	1	0	1	5
148	1	0	1	4
149	1	0	1	2
150	1	0	1	1
151	1	0	0	11
152	1	0	0	10
153	1	0	0	9
154	1	0	0	7
155	1	0	0	6
156	1	0	0	5
157	1	0	0	3
158	1	0	0	2
159	1	0	0	1
160	1	0	0	0

The end of the firſt Table calculated for one acre of ground.

Two Acres.

firſt ſide.	Second ſide.			
	pearches	parts.	feete	inch.
1	320	0	0	0
2	160	0	0	0
3	106	½	2	9
4	80	0	0	0
5	64	0	0	0
6	53	¼	[illegible]	[illegible]
7	45	½	[illegible]	[illegible]
8	40	0	[illegible]	[illegible]
9	35	½	[illegible]	[illegible]
10	32	0	[illegible]	[illegible]
11	29	0	[illegible]	[illegible]
12	26	½	[illegible]	[illegible]
13	24	½	[illegible]	[illegible]
14	22	¾	[illegible]	[illegible]
15	21	¼	1	[illegible]
16	20	0	0	[illegible]
17	18	¾	1	2
18	17	¾	0	5
19	16	¾	1	6
20	16	0	0	0
21	15	0	3	11
22	14	½	0	9
23	13	¾	2	8
24	13	¼	1	4

IRREG
PAGIN

The

The Table for two Acres.

First side.	The second side.			
	pearches.	parts.	feete.	inch.
25	12	3/4	0	9
26	12	1/4	0	11
27	11	3/4	1	8
28	11	1/2	2	[illegible]
[illegible]	[illegible]	[illegible]	0	10
[illegible]	[illegible]	[illegible]	2	9
[illegible]	[illegible]	[illegible]	1	2
[illegible]	[illegible]	[illegible]	0	0
[illegible]	[illegible]	[illegible]	3	3
[illegible]	[illegible]	[illegible]	2	8
[illegible]	[illegible]	[illegible]	2	4
[illegible]	[illegible]	[illegible]	2	3
[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	4
[illegible]	[illegible]	0	0	0
41	7	3/4	0	2
42	7	1/2	1	11
43	7	1/8	3	1
44	7	1/4	0	4
45	7	0	1	10
46	6	3/4	3	4
77	6	3/4	0	11
78	6	1/2	2	9

First side.	Second side.			
	pearches.	parts	feete.	Inch.
49	6	1/2	0	6
50	6	1/4	2	5
51	6	3/4	0	4
52	6	0	2	6
53	6	0	0	7
54	5	1/4	2	10
55	5	1/4	1	1
56	5	1/2	3	6
57	5	1/2	1	10
58	5	1/2	0	3
59	5	1/4	2	10
60	5	1/4	1	4
61	5	0	4	0
62	5	0	2	7
63	5	0	1	3
64	5	0	0	0
65	4	3/4	2	10
66	4	3/4	1	7
67	4	3/4	0	5
68	4	1/2	3	4
69	4	1/2	2	3
70	4	1/2	1	2
71	4	1/2	0	1
72	4	1/4	3	2

RREGULAR .
AGINATION .

One Acre.

first ſide.	Second ſide.			
	pearches.	parts.	feete	inch
145	1	0	1	8
146	1	0	1	6
147	1	0	1	5
148	1	0	1	4
149	1	0	1	2
150	1	0	1	1
151	1	0	0	11
152	1	0	0	10
153	1	0	0	9
154	1	0	0	7
155	1	0	0	6
156	1	0	0	5
157	1	0	0	3
158	1	0	0	2
159	1	0	0	1
160	1	0	0	0

The end of the firſt Table calculated for one acre of ground.

Two Acres.

firſt ſide.	Second ſide.			
	pearches	parts.	feete	inch.
1	320	0	0	0
2	160	0	0	0
3	106	$\frac{1}{2}$	2	9
4	80	0	0	0
5	64	0	0	0
6	53	$\frac{1}{4}$	1	4
7	45	$\frac{1}{2}$	3	6
8	40	0	0	0
9	35	$\frac{1}{2}$	0	11
10	32	0	0	0
11	29	0	1	6
12	26	$\frac{1}{2}$	2	9
13	24	$\frac{1}{2}$	1	10
14	22	$\frac{1}{4}$	1	9
15	21	$\frac{1}{4}$	1	4
16	20	0	0	0
17	18	$\frac{3}{4}$	1	2
18	17	$\frac{3}{4}$	0	5
19	16	$\frac{3}{4}$	1	6
20	16	0	0	0
21	15	0	3	11
22	14	$\frac{1}{2}$	0	9
23	13	$\frac{3}{4}$	2	8
24	13	$\frac{1}{4}$	1	4

The Table for two Acres.

Firſt ſide.	The ſecond ſide.			
	pearches.	parts.	feete.	inch.
25	12	3/4	0	9
26	12	1/4	0	11
27	11	3/4	1	8
28	11	1/4	2	0
29	11	0	0	6
30	10	1/2	2	9
31	10	1/4	1	2
32	10	0	0	0
33	9	1/2	3	3
34	9	1/4	2	8
35	9	0	2	4
36	8	3/4	2	3
37	8	1/2	2	5
38	8	1/4	2	0
39	8	0	3	4
40	8	0	0	0
41	7	3/4	0	1
42	7	1/2	1	11
43	7	1/4	3	1
44	7	1/4	0	4
45	7	0	1	10
46	6	3/4	3	4
77	6	3/4	0	11
78	6	1/2	2	9

Firſt ſide.	Second ſide.			
	pearches.	parts	feete.	Inch.
49	6	1/2	0	6
50	6	1/4	2	5
51	6	1/4	0	4
52	6	0	2	6
53	6	0	0	7
54	5	3/4	2	10
55	5	3/4	1	1
56	5	1/2	3	6
57	5	1/2	1	10
58	5	1/2	0	3
59	5	1/4	2	10
60	5	1/4	1	4
61	5	0	4	0
62	5	0	2	7
63	5	0	1	3
64	5	0	0	0
65	4	3/4	2	10
66	4	3/4	1	7
67	4	3/4	0	5
68	4	1/2	3	4
69	4	1/2	2	3
70	4	1/2	1	2
71	4	1/2	0	1
72	4	1/4	3	2

The table for three acres of ground.

firſt ſide.	Second ſide.			
	pearches	parts	feete	Inch
73	4	¾	2	2
74	4	¼	1	2
75	4	¼	0	3
76	4	0	3	5
77	4	0	2	6
78	4	0	1	8
79	4	0	0	10
80	4	0	0	0
81	3	¾	3	3
82	3	¾	2	6
83	3	¾	1	8
84	3	¾	0	11
85	3	¾	0	2
86	3	½	3	7
87	3	½	2	11
88	3	½	2	3
89	3	½	2	6
90	3	½	0	11
91	3	½	0	3
92	3	¼	3	9
93	3	¼	3	1
94	3	¼	2	6
95	3	¼	1	11
96	3	¼	1	4
97	3	[illegible]	0	9
98	3	¼	0	3
99	3	0	3	10
100	3	0	3	3
101	3	0	2	9
102	3	0	2	3
103	3	0	1	9
104	3	0	1	3
105	3	0	0	0
106	3	0	0	0
107	2	¾	3	0
108	2	¾	3	0
109	2	¾	3	0
110	2	¾	2	0
111	2	¾	2	0
112	2	¾	1	0
113	2	¾	1	0
114	2	¾	0	0
115	2	¾	0	0
116	2	¾	0	0
117	2	½	3	0
118	2	½	3	0
119	2	½	3	0
120	2	½	2	0

A Table to lay out two Acres of ground.

first ſide	Second ſide.			
	pearches.	parts.	feete	inch
121	2	$\frac{1}{3}$	2	4
122	2	$\frac{1}{3}$	2	0
123	2	$\frac{1}{3}$	1	8
124	2	$\frac{1}{3}$	1	3
125	2	$\frac{1}{3}$	0	11
126	2	$\frac{1}{3}$	0	7
127	2	$\frac{1}{3}$	0	3
128	2	$\frac{1}{3}$	0	0
129	2	$\frac{1}{4}$	3	9
130	2	$\frac{1}{4}$	3	5
131	2	$\frac{1}{4}$	3	2
132	2	$\frac{1}{4}$	2	10
133	2	$\frac{1}{4}$	2	6
184	2	$\frac{1}{4}$	2	3
135	2	$\frac{1}{4}$	1	11
136	2	$\frac{1}{4}$	1	8
137	2	$\frac{1}{4}$	1	4
138	2	$\frac{1}{4}$	1	1
139	2	$\frac{1}{4}$	0	10
140	2	$\frac{1}{4}$	0	7

first ſide	Second ſide.			
	pearches	parts.	feet	inch
141	2	$\frac{1}{4}$	0	3
142	2	$\frac{1}{4}$	0	0
143	2	0	3	11
144	2	0	3	8
145	2	0	3	4
146	2	0	3	1
147	2	0	2	11
148	2	0	2	8
149	2	0	2	5
150	2	0	2	2
151	2	0	1	11
152	2	0	1	8
153	2	0	1	6
154	2	0	1	3
155	2	0	1	0
156	2	0	0	10
157	2	0	0	7
158	2	0	0	5
159	2	0	0	0
160	2	0	0	0

The end of the ſecond Table calculated for two acres of ground.

The

The table for three acres of ground.

firſt ſide	Second ſide.				firſt ſide	Second ſide.			
	pearches	parts	feete	Inch		pearches	parts.	feete	inch.
1	280	0	0	0	25	19	0	3	3
2	240	0	0	0	26	18	1/4	3	5
3	160	0	0	0	27	17	3/4	0	5
4	120	0	0	0	28	17	0	2	4
5	96	0	0	0	29	16	1/2	0	10
6	80	0	0	0	30	16	0	0	0
7	68	1/2	1	0	31	15	1/4	3	10
8	60	0	0	0	32	15	0	0	0
9	53	1/4	1	1	33	14	1/2	0	9
10	48	0	0	0	34	14	0	1	11
11	43	1/2	2	0	35	13	1/2	3	6
12	40	0	0	0	26	13	1/4	1	4
13	36	3/4	2	1	37	12	3/4	3	8
14	34	1/4	0	1	38	12	1/3	2	2
15	32	0	0	0	39	12	1/4	0	11
16	30	0	0	0	40	12	0	0	0
17	28	0	3	1	41	11	1/2	3	5
18	26	1/3	2	0	42	11	1/4	2	11
19	25	1/4	0	2	43	11	0	2	8
20	24	0	0	0	44	10	3/4	4	7
21	22	3/4	1	0	45	10	2/3	2	9
22	21	3/4	1	0	46	10	1/4	3	0
23	20	3/4	1	2	47	10	0	3	6
24	20	0	0	0	48	10	0	0	0

The

The Table to lay out three acres of ground.

firſt ſide.	Second ſide.				firſt ſide.	Second ſide.			
	pearches	parts	feete	Inch		pearches.	parts.	feete	inch.
49	9	3/4	0	9	72	6	1/2	2	9
50	9	1/2	1	7	73	6	1/2	1	2
51	9	1/4	2	8	74	6	1/4	3	10
52	9	0	3	9	75	6	1/4	2	5
53	9	0	0	11	76	6	1/4	1	1
54	8	3/4	2	3	77	6	0	3	10
55	8	1/2	3	9	78	6	0	2	6
56	8	1/2	1	2	79	6	0	1	3
57	8	1/4	2	9	80	6	0	0	0
58	8	1/4	0	5	81	5	3/4	2	10
59	8	0	2	2	82	5	3/4	1	8
60	8	0	0	0	83	5	3/4	0	6
61	7	3/4	1	11	84	5	1/2	3	6
62	7	1/2	3	11	85	5	1/2	2	5
63	7	1/2	1	11	86	5	1/2	1	4
64	7	1/2	0	0	87	5	1/2	0	3
65	7	1/4	2	2	88	5	1/4	3	3
66	7	1/4	0	4	89	5	1/4	2	3
67	7	0	2	8	90	5	1/4	1	3
68	7	0	0	11	91	5	1/4	0	3
69	7	3/4	3	4	92	5	0	3	0
70	6	3/4	1	9	93	5	0	2	0
71	6	3/4	0	2	94	5	0	1	0

The table for three acres of ground.

firſt ſide;	Second ſide.			
	pear-ches	parts	yard	Inch
95	5	0	0	10
96	5	0	0	0
97	4	$\frac{3}{4}$	3	3
98	4	$\frac{3}{4}$	2	5
99	4	$\frac{3}{4}$	1	7
100	4	$\frac{3}{4}$	0	9
101	4	$\frac{3}{4}$	0	0
102	4	$\frac{1}{2}$	3	4
103	4	$\frac{1}{2}$	2	7
104	4	$\frac{1}{2}$	1	10
105	4	$\frac{1}{2}$	1	2
106	4	$\frac{1}{2}$	0	5
107	4	$\frac{1}{4}$	3	10
108	4	$\frac{1}{4}$	3	2
109	4	$\frac{1}{4}$	2	6
110	4	$\frac{1}{4}$	1	10
111	4	$\frac{1}{4}$	1	2
112	4	$\frac{1}{4}$	0	7
113	4	0	4	1
114	4	0	3	5
115	4	0	3	10
116	4	0	2	3
117	4	0	2	8

firſt ſide	Second ſide.			
	pear-ches.	parts.	feete	inch.
118	4	0	1	1
119	4	0	0	6
120	4	0	0	0
121	3	$\frac{3}{4}$	3	6
122	3	$\frac{3}{4}$	3	0
123	3	$\frac{3}{4}$	2	6
124	3	$\frac{3}{4}$	1	11
125	3	$\frac{3}{4}$	1	5
126	3	$\frac{3}{4}$	0	11
127	3	$\frac{3}{4}$	0	5
128	3	$\frac{3}{4}$	0	0
129	3	$\frac{1}{2}$	3	7
130	3	$\frac{1}{2}$	3	2
131	3	$\frac{1}{2}$	2	8
132	3	$\frac{1}{2}$	2	3
133	3	$\frac{1}{2}$	1	9
134	3	$\frac{1}{2}$	1	4
135	3	$\frac{1}{2}$	0	11
136	3	$\frac{1}{2}$	0	5
137	3	$\frac{1}{2}$	0	0
138	3	$\frac{1}{4}$	3	9
139	3	$\frac{1}{4}$	3	4
140	3	$\frac{1}{4}$	2	11

A Table to lay out three Acres of ground.

firſt ſide	Second ſide.			
	pearches	parts.	feet	inch
141	3	¼	2	6
142	3	¼	2	1
143	8	¼	1	9
144	3	¼	1	4
145	3	¼	0	11
146	3	¼	0	7
147	3	¼	0	3
148	3	¼	4	0
149	3	0	0	7
150	3	0	4	3

firſt ſide.	Second ſide.			
	pearches.	parts.	feete	inch
151	3	0	2	1
152	3	0	2	7
153	3	0	2	3
154	3	0	1	11
155	3	0	1	6
156	3	0	1	3
157	3	0	0	11
158	3	0	0	6
159	3	0	0	3
160	3	0	0	0

The end of the third table for three acres of Statute meaſure.

Chap. XXXII.

The vſe of the former Tables.

The vſe of the former Tables.

THE vſe of the thrée former Tables is, to lay out one acre of ground, two acres of ground, or thrée acres of ground, in any kind of parallelogram, which you ſhall thus performe.

Conſider how many pearches you will haue the one ſide of the Acre to conteine, and that meaſure out with your Chayne, and there make a marke: note then how many Pearches you meaſured in that ſide, which call the firſt ſide: Now, to lay out one, two or thrée acres of land, finde the number of thoſe perches you haue meaſured in the former Tables in the Rowe of the left hand vnder the title of the firſt ſide: then looke in the table right-wards vnder this title, the ſecond ſide, where you ſhall ſée the lēgth of the ſecond ſide of the acre, in perches, parts of perches, &c. This founde, meaſure from one of the ends of the firſt ſide Orthogonaliter or Squyre-wiſe, the number of pearches, &c. laſt found, and let that be the length of the ſecond ſide, ſo haue you gotten two ſides of the acre; then meaſure ſo many perches from the ende of this laſt meaſured line (& that Squyrewiſe) as the length of the firſt ſide was: then from the ende of that line meaſure ſo many perches as the length of the ſecond ſide was, which you ſhal meat with the firſt ſide, ſo haue you finiſhed.

Example.

I Haue allotted vnto mée 13 pearches one way, for to make yͤ one ſide of an acre which I am allowed: I wold know how long the ſecond ſide ſhould bée: Repayre vnto the firſt table, and there in the firſt Colume vpon the left hand finde 13 perches. Vnder yͤ title of firſt ſide rightwards, anſwering to which vnder the title of ſecond ſide, ſhall you find 12 pearches & ½ of a perch, 11 inches and better, and ſo long muſt the ſecond ſide be, hauing theſe two ſides, the two other are like therunto, therefore procéed as you be taught before: The like order is to be obſerued in laying out of 2 or 3 acres: And if you would lay out 4. acres, looke in 2. acres, and that you finde in the ſecond ſide double, or adde that you find for one and 3 together: and if you would lay out 6 Acres, double that you finde for the ſecond ſide in thrée Acres: and if you would lay out 9 Acres, treble it. &c.

Note in euery Table vnder the title of inch, one prick ſtandeth for halfe an inch, & 2. prickes for leſſe then halfe an inch.

Now (for a time) we will digreſſe to ſhewe you other Nouelties, ſo ſhal you be more apt when we returne to our former intendments of meaſuring ground.

CHAP. XXXIII.

To know if Water will be brought vnto any place.

If water will be brought vnto any place.

Take the diſtance betwixt the Spring-head and the place whereto you would bring the water, which multiply in it ſelfe; adde the product therof to the Square of the earthes Semidiameter; viz. to the ſquare of 3436 and $\frac{4}{11}$ Italian miles, then out of the product therof extract the ſquare rote, and then from that ſquare rot, take 3436 & $\frac{4}{11}$ miles, ẏ remainder is the difference betwixt the line of leuel & the water or circular leuel.

But this you may doe with more eaſe and that without Arithmetick by your Staffe, if you note but the Chapter of the difference of the Horizontal and hipothenuſall lines.

CHAP. XXXIIII.

The Deſcription and vſe of the Table ſet downe in the ende of the firſt Booke, to be placed vpon the hollow Staffe called the Table of Planimetria.

To meaſure boords.

This Table is deuided into 6 Columnes, and one litle row vpon the left hand, then euery of thoſe Columnes is ſubdeuided into two rowes: in the firſt Columne is placed ẏ parts of an inch, which happen in the taking of the breadth of your Boords, Glaſſe, &c. ſet downe thus ¼ ½ ¾, ſignifying one quarter, one halfe, and three quarters of an inch: then the Table is deuided croſſe into 6 great columnes, wherein is placed Capitall letters frõ 1 to 36. which ſtand for inches; wherein the breadth of any glaſſe, &c. is to be ſought in whole inches, as the parts of inches were before: all other pendant Columnes expreſſe the length of your rule ẏ muſt be laid out to make a foote of boords, &c. as will better appeare in the example.

A Table for Boord and glaſſe meaſure, &c. called the *Table of Planimetria.*

P. Y.			VI		XII		XVIII		XXIIII		XXX	
	foot	yn:	foot	ync:	yn.	par:	yn:	par:	yn:	par:	ync:	par:
			2	0	12	0	8	0	6	0	4	4/5
1/4	48		1	11 1/25	11	3/5	7	7/8	5	15/16	4	3/4
1/2	24		1	10 1/7	11	1/2	7	4/5	5	7/8	4	5/7
3/4	16		1	9 1/3	11	2/7	7	2/3	5	4/5	4	2/3
	I		VII		XIII		XIX		XXV		XXXI	
1	12		1	8 4/7	11	1/16	7	4/7	5	3/4	4	5/8
1/4	9	7 1/5	1	7 2/5	10	7/8	7	1/2	5	2/3	4	4/7
1/2	8	0	1	6 1/5	10	2/3	7	3/8	5	5/8	4	1/2
3/4	6	10 2/7	1	6 4/7	10	1/2	7	2/7	5	5/8	4	1/2
	II		VIII		XIIII		XX		XXVI		XXXII	
2	6	0	1	6	10	2/7	7	1/5	5	1/2	4	1/2
1/4	5	4	1	5 3/7	10	3/29	7	1/8	5	1/2	4	3/7
1/2	4	9 3/5	1	4 15/16	9	7/8	6	31/32	5	3/7	4	3/8
3/4	4	4 3/8	1	4 3/7	9	3/4	6	15/16	5	3/8	4	1/3
	III		IX		XV		XXI		XXVII		XXXIII	
1	4	0	1	4	9	3/5	6	6/7	5	1/3	4	3/8
1/4	3	8 4/13	1	3 4/7	9	3/7	6	4/7	5	2/7	4	2/7
1/2	3	5 1/7	1	3 1/7	9	2/7	6	5/7	5	2/9	4	1/6
3/4	3	2 2/5	1	2 3/4	9	1/8	6	5/8	5	1/5	4	1/4
	IIII		X		XVI		XXII		XXVIII		XXXIIII	
1	3	0	1	2 2/5	9	0	6	1/2	5	1/7	4	1/4
1/4	2	9 7/8	1	2 1/21	8	6/7	6	1/2	5	3/31	4	3/16
1/2	2	8	1	1 3/4	8	3/4	6	3/8	5	1/16	4	1/6
3/4	2	6 1/3	1	1 3/8	8	5/8	6	1/3	5	0	4	1/7
	V		XI		XVI		XXII		XXIX		XXXV	
1	2	4 4/5	1	1 1/11	8	1/2	6	1/4	5	0	4	1/8
1/4	2	3 3/7	1	1 4/5	8	1/3	6	1/5	4	7/8	4	1/12
1/2	2	2 1/5	1	1/2	8	1/5	6	1/8	4	7/8	4	1/16
3/4	2	1 1/23	1	1/4	8	1/12	6	1/16	4	5/6	4	1/32

Examples

Example.

I haue a peece of glaſſe 9 inches and $\frac{3}{4}$ broad, I would know how much in length would make a foote ſquare. Firſt find 9 inches in ſome of the croſſe rowes amongſt the great letters, which you ſhall find to be in the ſecond great pendant row, then in the firſt row vpon the left hand I ſéeke $\frac{3}{4}$ parts, and drawing rightwards from thence, vntill I come vnder IX, there do I finde 1 foote 2 inches, and $\frac{3}{4}$ of an inch, and ſo much meaſure in length muſt the glaſſe be to make one foote ſquare: So that I may conclude a péece of glaſſe 9 inches and $\frac{3}{4}$ of an inch broad, and one foote two inches, and $\frac{3}{4}$ of an inche long maketh one ſquare foote, which is 144 ſquare inches.

Then ſuppoſe my glaſſe were 3 foote 8 inches and $\frac{1}{4}$ of an inch long, I then take 1 foot 9 inches and $\frac{3}{4}$ parts, & meaſure the length of the glaſſe, noting howe often it containes the length of 1 foote 9 inches and $\frac{3}{4}$, which I find 3 times: therefore I conclude that there is 3 ſquare féete of glaſſe contained in the whole, which was 9 inches, &c. long, and 1 foote, &c. broad.

Another Example.

I haue a péece of boord 15 inches one way, I would know how much of my rule muſt be layd out to make a ſquare foote. Seeke 15 inches, as before, and then in the margent vpon the left hand find the figure 1, from which directing your eye rightwards, vntill you come vnder 15, there ſhall you finde 9 inches and $\frac{3}{5}$ parts of an inch, and ſo much muſt the other ſide be, ſo that I may conclude, a boord or pauement, &c. 15 inches one way, and 9 inches $\frac{3}{5}$ parts, the other is a iuſt ſquare foote, and then if the boord be many féete long, ſée how often you can finde 9 inches and $\frac{3}{5}$ parts therein, and ſo many féete of boord may you ſafely conclude to be contained in the ſaid peece of boord.

And if the breadth exceed the table, then deuide the breadth into parts, and ſo proceed.

The ground of this working is thus. You muſt vnderſtand that the diuiſions of the boord meaſure, is the breadth of the boord giuen, to find how much in length will make a foote of boord.

The ground of boord meaſure.

To do which, you muſt alſo vnderſtand, that a ſquare foote is 144 ſquare inches. Therefore if you will knowe how long the ſecond ſide muſt be, deuide 144 by the ſide giuen, and the product ſheweth thy demaund.

Example.

I would know how many inches the ſecond ſide ſhould be to make a foote ſquare, the firſt ſide which I meaſure being 36 inches, deuide 144 by 36, and the quotient will be 4 inches, which ſheweth that the ſecond ſide muſt be 4 inches long to make a ſquare foote.

And ſo ſhall you finde 32 to yéeld his ſecond ſide to be foure inches, and $\frac{1}{2}$, &c. ſo of all the reſt, and thus take the ground hereof briefly.

Chap. XXXV.

The vſe of the Table, called the Table of Solidmetria.

To meaſure timber.

This kinde of meaſure is to meate all kinde of peeces of timber, ſtone. pillars, or ſuch like ſolide things, which ſheweth how much in length will make a foote of timber, the ſide of the ſquare thereof being giuen; the working whereof is thus.

Firſt get the ſquare thereof in equall parts of meaſure: for which purpoſe M. Digges hath well calculated a Table, notwithſtanding you ſhall go neere inough to worke, if you do but gird the ſaid peece of timber about, and then take the fourth part thereof for the ſquare of ſuch a peece of timber; the ſide of the ſquare found in inches, reſort to your table of Solidmetria, and there in one of the rowes vnder this letter S, ſignifying ſquare, finde the ſquare of the ſayd peece of timber, anſwering to which rightwards ſhall you finde the feete, inches, or parts of inches, which you muſt meaſure in length, to make a foote of timber.

Example.

The ſquare of a peece of timber is eight inches, anſwering to which is two feete, three inches, and ſo much of my rule muſt I lay out to make a foote ſquare of timber: therefore if the peece of timber had beene nine foote long, there muſt be 3 square feete of timber therein, because 1 foote, 3 inches is fiue times contained in 9 foote.

And so if the peece had bene longer, you muſt haue ſeene how often you could haue found by meaſure 2 foote and 3 inches therein, and ſo many foote of timber might you conclude to be in the ſayd peece, ſo of all the reſt.

The ground.

The ground of timber meaſure.

Hereof is deuided the cubicall inches in a foote, viz. 1728 by the ſquare of the timber giuen, the quotient ſheweth how many inches of your rule muſt be layde out to make a ſquare foote.

Example.

The ſquare is giuen to be 36 inches, I would knowe how much of my rule ought be layd out to make a ſquare foote: multiply 36 by 36, which maketh 1296, by which deuide 1728, and the quotient will be 1 $\frac{1}{3}$, and ſo much of your rule muſt be layd out to make a cubicall foote, that is, a foot to containe 12 times ſo much as a plaine ſquare foote of 144 inches: by theſe tables may you place boord and timber meaſure vpon the Carpenters rule truly and preciſely.

CHAP. XXXVI.

Of another kind of new working in timber meaſure.

A new kind of timber meaſure.

This kind of working ſhall ſhew you how many foote of Timber there is conteined in euery foote of length, the ſide of the ſquare thereof being giuen, and is knowne by extracting the ſquare root of ſo many ſquare feete as the length containes: as if you would know how many inches ſquare that peece of timber muſt be as ſhould containe 2 foote of timber in one foote of length, worke thus.

The ſquare inches in one foote be 144, which doubled maketh 288, the ſquare roote whereof is 16 $\frac{32}{33}$, which ſheweth 16 $\frac{32}{33}$ inches ſquare doth make 2 foote of timber in each foote of length: the like of any other.

CHAP. XXXVII.

Of Shide meaſure.

Shide meaſure.

Shide meaſure ſheweth how many ſhides of timber do conteine in each foote of length: for you muſt note that a ſhide of timber is halfe a foote of timber, and ſuch a peece whoſe end is 18 inches over, and whoſe length is 4 foote, and is thus wrought. Multiply the number of ſhides that you would know by 18, and from that product extract the ſquare roote which ſheweth how many inches ſquare that peece of timber muſt be that ſhal containe the number of ſhides given therein.

Example.

I would know what ſquare the peece muſt beare that ſhall containe 15 ſhides in 4 foote of length. Firſt multiply 15 by 18, there commeth 270, the ſquare roote whereof is 16 [illegible] your demaund, ſo of all the reſt.

Theſe diviſions of ſhides ſerve for the meaſuring of a timber tree that ſtandeth, thus performed. Gird the tree about 4 foote from the roote, and take ¼ of the girding, then ſee how many ſhides be contained in that ſquare, and for the next 4 foote abate 2 ſhides for the Trapizing of the tree, and ſo for all the 4 footes in the length thereof, then adde all the ſhides together, ſo have you the contents of the tree.

CHAP. XXXVIII.

To fetch all manner of dimentions by helpe of the Cord diviſions placed vpon the backe of the legges, with more eaſe then before hath bene ſet downe, and firſt of altitudes.

Altitudes by protracting.

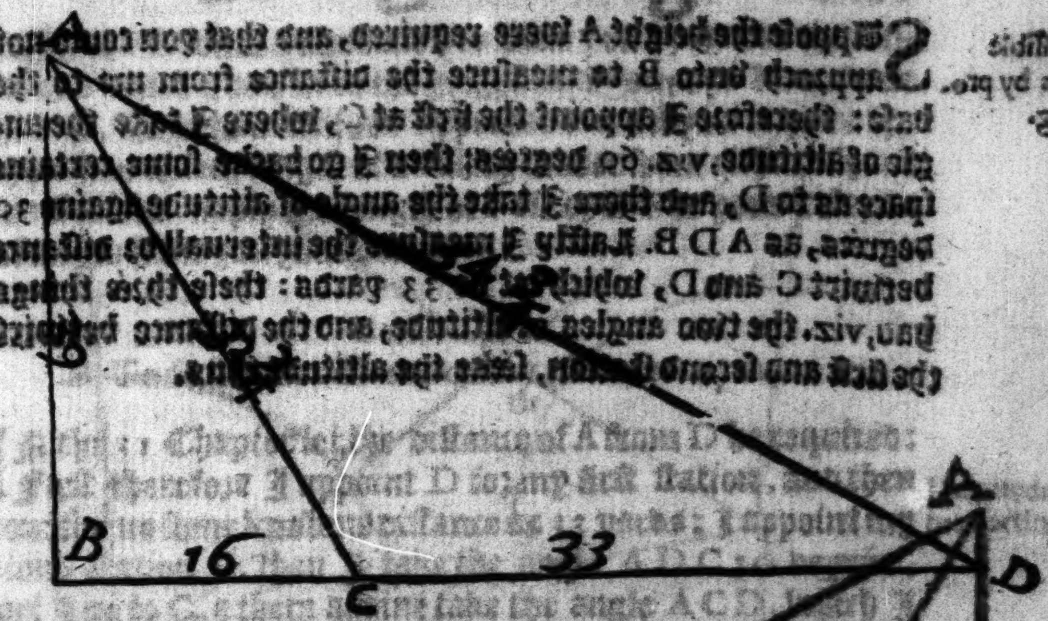
All altitudes are perpendicularly elevated upon the face of the earth: and therefore make right angles with the line of levell, the ſearching whereof is thus.

Go as neere, or ſtand as farre off the altitude as you pleaſe, and there take the angle of altitude, as you are inſtructed in the ſecond Booke, Chapter [illegible], which note before; then meaſure the true diſtance of the ſame tower from your ſtanding, which alſo note before, and then fall to worke thus. Draw a ſtraight line, and at the one end thereof erect a perpendicular, call this line the perpendicular, and the firſt line, the line of levell: then open your Compaſſe unto ſo many number of pearches, yards, &c. as you noted the diſtance of the tower from your ſtanding, which lay upon the ground line from the interſection of the perpendicular therewith towards the other end. Laſtly, where the foote of your Compaſſe falleth there make a point, [illegible] the angle of altitude being taken, and [illegible] the line of the angle forth infinitly, note at laſt the interſection of the ſayd line with the perpendicular, the diſtance betwixt the ſayd interſection and the baſis is the altitude which is found by applying the ſayd diſtance unto your former ſcale.

Example.

Let A B be an altitude, C your ſtation, where you take the quantity of the angle A C B 60 degrees,* then I meaſure my diſtance from C to B 16 yardes, theſe two I note downe, then I drawe the line E upon faire paper infinitly, then upon F the extremes of E G I, erect the perpendicular F E; then I lay downe 16 yeardes in the line F G, viz. E F, and upon F H protract an angle of 60 degrees, by the ſecond Chapter, as I H E.

* Lib. 2. cap. 4. pro. 5.



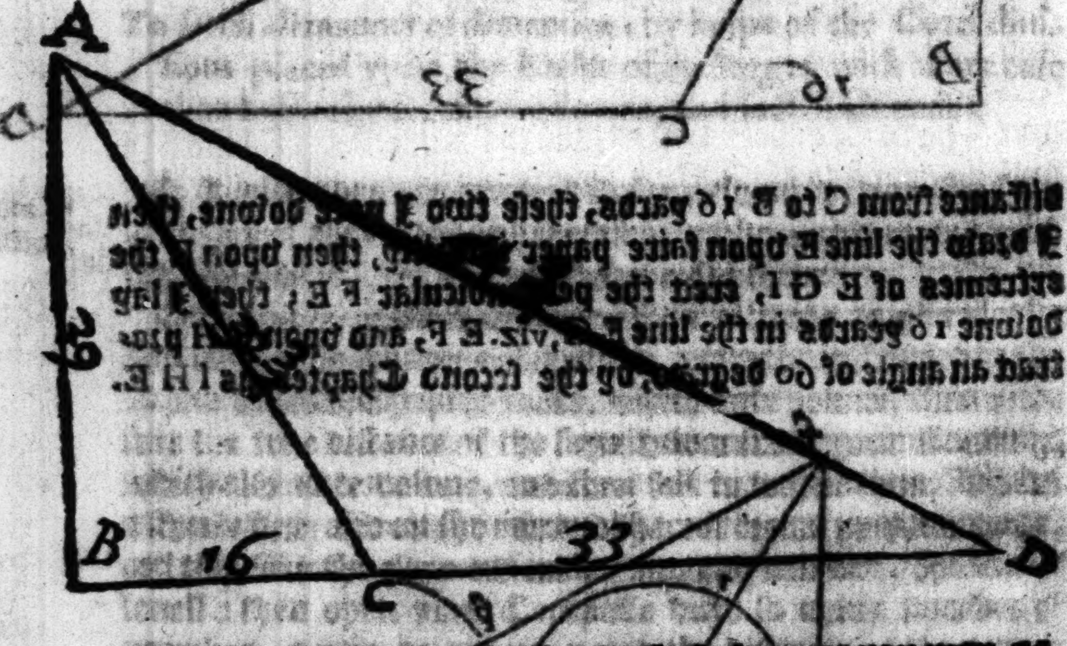
[illegible] which is the line E F [illegible]

E F, and apply the same unto my scale: which I find to containe 29 equall parts betwixt the two feet of my Compasse: therefore I conclude the altitude 29 feete high, in like manner must I have found the Hypothenusall line G A for the length of any scaling ladder.

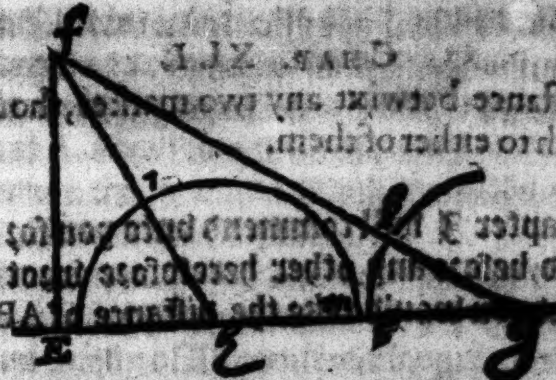
To search out inaccessible heights.

Inaccessible heights by protracting.

Suppose the height A were required, and that you could not approch unto B to measure the distance from me to the base: therefore I appoint the first at C, where I take the angle of altitude, viz. 60 degrées: then I go backe some certaine space as to D, and there I take the angle of altitude againe 30 degrées, as A D B. Lastly I measure the intervall or distance betwixt C and D, which let be 33 yards: these thrée things had, viz. the two angles of altitude, and the distance betwixt the first and second station, séeke the altitude thus.



You shall draw a ground line forth so long as you may, as E G, then about the middest thereof, as at G towards D, lay out 33 yards, as G D, and upon D protract an angle of 30 degrées, as F G M: then note the intersection of F G, and H F, and there make the point F, from which point let fall a perpendicular upon the ground line E G, as F K. Lastly, apply the length



length of F E unto your ſcale, ſo haue you 29 yards the altitude, to which if you adde the height that your eye was aboue the baſe, the whole altitude appeares: and if you require the Hypothenuſall or length of a ſcaling ladder from either of your two ſtations, apply the length of F H, or G F to your ſcale, as before, ſo haue you your deſire.

CHAP. XL.

To ſeeke the diſtance of any place from you.

In the 31 Chapter let the diſtance of A from D be required: Firſt therefore I appoint D for my firſt ſtation, and then from thence ſome knowne diſtance as 33 yards; I appoint my ſecond ſtation C, then I take the angle A D C 30 degrées, next I go to C, & there againe take the angle A C D, which I find 120 degrées; theſe thrée things I note downe, viz. two angles, and one line, then I protract thus.

Longitudes by protracting.

First as I am wont I draw a blind line forth at length E G, then vpon the extreme, as vpon G protract an angle of 30 degrées, as K G L, then from G by K I draw a line forth infinitely, next I lay downe the length of 33 yards from G towards E, and where the foote of my Compaſſe falleth I make the point H, whereupon I protract an angle of 120 degrées in H I (or if you will, you may take 120 from 180: ſo will there reſt 60, the quantity of the angle F H E, * which angle you may protract in ſtead of the other) then note the interſection of the line G F, and G H, which let be at F. Laſtly by applying the length of F G to your ſcale, you haue the diſtance of D A 58 yards, and ſo may you meaſure the other line C A.

The figures in the 40 Chapter ſerueth here.

Eu. lib. 1. p. 13 & 14.

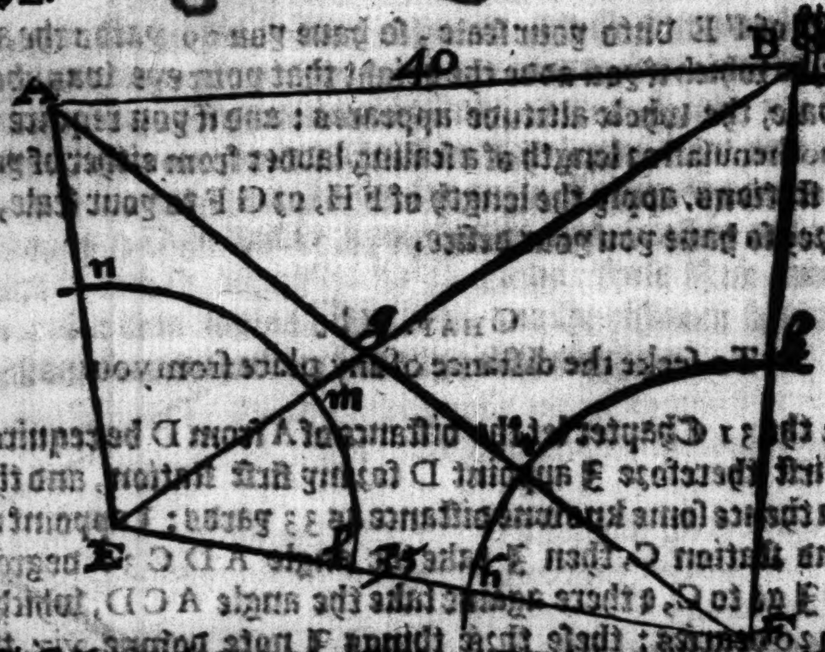
Ra. l. 5. p. 8. conſ. 1.

Note in taking the angle A C B, if you had made the fiduciall edge of the index C O point iuſt to D, as O C doth, then might you haue taken the angle A C B, as you did in the 31 Chapter.

Chap. XLI.

To take a diſtance betwixt any two markes, though you cannot aproach to either of them.

THis Chapter I will commend vnto you for eaſe, facility, and ſpeed, before any other heretofore taught whatſoeuer. Imagine that you would take the diſtance of AB, ſtanding at F or E.



Firſt I appoint me two ſtations F E, in a knowne diſtance from me, as 35 yards: then I take the quantity of the angle A F E, and note it downe, viz. 30 degrees: Next I take the angle A F B, and note that downe, viz. 48 degrees: theſe two angles noted for my firſt ſtation, then I repaire to the ſecond ſtation as to E, and there obſerue the angle F E B, and A E B, which I note downe for the angles of my two ſtations, viz. 45 and 60 degrees, then I protract thus.

Firſt, I draw a line at all aduentures, as E F, whereon I appoint 35 yards taken with my compaſſe from my ſcale, then vpon the point F I protract an angle of 30 degrees, as I F H, then from F by I I draw a line infinitly, as to A, next I protract an angle of 48 degrees, as L F K, drawing a line from F by K out at length, as to B, ſo haue I finiſhed the angles obſerued at my firſt ſtation F, then I go to E, and there protract an angle of 45 degrees, as L E M, drawing a line from E by M, out at length, vntill it interſect with the line F B, as at B, next I protract an angle of 60 degrees, as N E M, laying a rule vpon E and N, and drawing forth a line vntill it interſect with the line F A, as at A, then from the interſection A, to the interſection B, I draw a ſtraite line A B, which applied vnto the ſcale ſheweth the diſtance, viz. 40 yards.

In like manner may you meaſure the line E B, or F A, or the line F B, or E A, by applying the length thereof vnto your ſcale; and thus briefly of Dimenſions by protracting.

And here note that you may performe any kinde of Dimenſion after this way, (I meane by protracting) mentioned in any of my former bookes. And this kind of worke I place here (as it were out of order) for that you may hereby take the length of hedges, or any diſtance in any field, for the ready deuiding or ſeparating of the ſame without chaine meaſure.

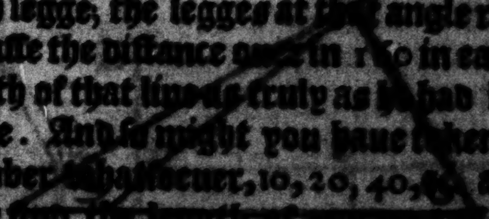
CHAP. XLIII.

To vſe the legges of the Geodeticall Staffe as any kinde of Scale, according to 10, 16, 20, 30, &c. in the inch.

IN the ſecond Chapter of the fifth booke I taught you to make a Scale, and here I let you to vnderſtand that you may vſe the equall parts vpon the legges in as good ſort as if it were a Scale, by taking the equall parts ſet vpon the legges thence, as you would from a Scale. [illegible] truly, that the [illegible] be ſo large, that [illegible] ſame any number aboue 100, [illegible] whereof I will teach you a moſt excellent way.

Of the proportion of lines.

Suppoſe you haue a line 100 pearches long, [illegible] to be a baſe line, vpon which you would raiſe a perpendicular 160 pearches long. Firſt open your Compaſſe to what ſmall diſtance you pleaſe, and that wideneſſe ſet ouer in a hundred in each legge, the legges at that angle reſting, take with your Compaſſe the diſtance ouer in 160 in each legge, ſo haue you the length of that line as truly as if it had bene taken from a ſmall Scale. And ſo might you haue taken the length of any other number whatſoeuer, 10, 20, 40, 60, and by this meanes may you know the length of any part of a line: and thereby alſo may you vſe the legges as any kind of Scale, according to 8, 10, 16, 20, 30, &c. in the inch, [illegible].



Cap. 45. pro. 6. To vſe the legs of any kinde of Scale.

I haue obſerued the angles, and meaſured the lines in a field, according to the doctrine of the firſt part of this Booke, and am required to protract the plat according vnto a Scale of 16 in the inch, which I eaſily performe, as thus.

Fit the length of an inch (which you may take from the equall diuiſions on the legges, for 8 make an inch) ouer in 16 equall parts on each legge; the legge ſo reſting, take the diſtance ouer in each legge from number to number, ſo may you expreſſe any line aſſigned: as if you would expreſſe a line of 20 pearches by a ſcale according vnto 16 in the inch, the legge reſting as before, take the diſtance ouer from 20 to 20, which is your deſire; and ſo of any other number.

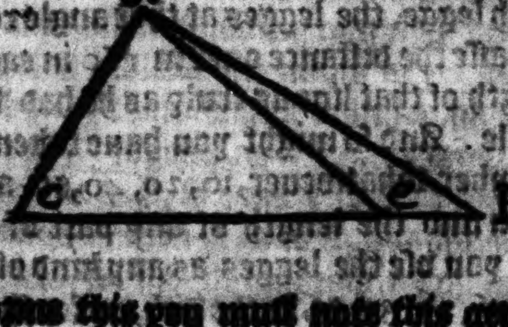
Now if you would apply them vnto a ſcale of 20 or 30 in the inch, yͤ labour is no more but to fit the inch ouer in the aſſigned number, into which it is deuided, as in 20 or 30, and then worke as before: whereby you may note the ſingular vſe of this Chapter, by helpe whereof you may caſt vp any aſſigned plat according vnto any Scale, reduce maps and plats from greater formes to leſſe, or from leſſe to greater; performe the Art of Little foote in proportioning images, pictures, houſes, &c. and ſtill auoide the coſt and multitude of Scales.

CHAP. XLIII.

To deuide a peece of ground as ſhall be aſſigned.

To deuide ground inſtrumentally.

Fiue men haue all alike title vnto one tryangular peece of ground, the fourth man compoundeth with three of them for their titles: ſo then there is but two haue title to the ſayd peece, and they agree to incloſe it, the purchaſor muſt haue foure of the fiue parts, and the other man but one of the fiue parts vnto his ſhare: I demaund how I ſhall performe this?



To performe this you muſt note this generall, that if the baſe of a tryangle be cut according unto a proportion aſſigned, a right line drawne from the angle ſubtended by the baſe to any poynt therein, ſhall deuide the tryangle according unto the proportion aſſigned; let the tryangle A B C be a peece of ground to be deuided, as is ſayd.

I deuide C B in ſuch proportion as 4 is to 3, by the 3 Prop. 45 Chapter, ſo that C B the baſe is ſo cut in the poynt E, that C E is to E B, as 4 to 5: therefore a line drawne from A to E deuideth the tryangle, as was propoſed. In like manner could I teach you to deuide a parallelogram: but for becauſe there be tables for the purpoſe ſet downe before, I will onely ſhewe you the propoſition and no more.

If the baſe of a parallelogram be deuided according unto a proportion aſſigned, a perpendicular reared upon that poynt in the baſe where the diuiſion was made, ſhall deuide the parallelogram giuen, according to the proportion aſſigned.

Chap. XLIIII.

The rare Metamorphoſing of all Geometricall figures, both regular or irregular, into any regular figure, for the ſpeedie meaſuring thereof by the Geodeticall Staffe.

Metamorphoſis 1.

Of all figures a circle is the moſt perfect, and hitherunto hath bene moſt troubleſome to be meaſured: for which cauſes we will begin therewith.

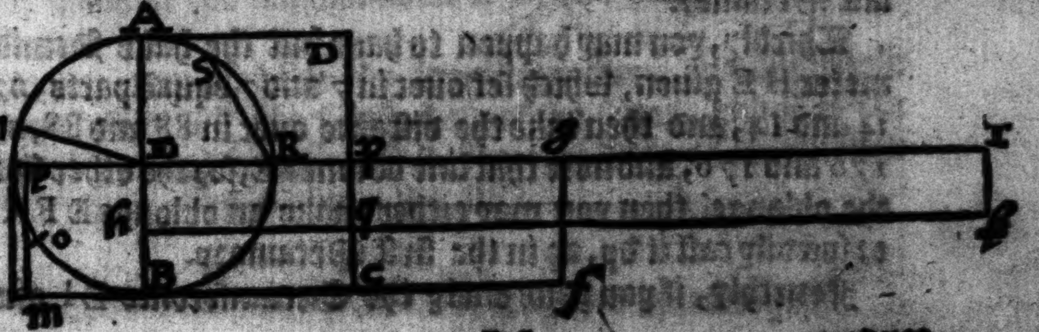
A circle is a round plaine, as is proued, * the meaſuring whereof by this inſtrument is grounded upon Eucl. l. 12. p. 2. Ram. l. 15. p. 2. & l. 19. p. 2. Conſ. 1. 2. & 3.

Circulus quid. Eu. l. c. 15. Ra. l. 15. p. 2.

To reduce a Circle into an Oblonge.

The eaſieſt way poſſible I can finde to meaſure a circle, is to finde two lines, which being multiplied in themſelues may

Archimedes demonſtrauit aream circuli aequalem



eſſe triangulo rectangulo, cuius vnum latus ex his quæ rectum comprehendunt, angulum ipſius circulo ſemidiametro, reliquum circumferentiæ fuerit æquale.

produce the Area of the Circle: and for that in all other obſeruations you be required as well to know the Circumference, as the Diameter, before you can finde two ſuch lines, I will teach you here a way by helpe of this inſtrument: that hauing but any part of the Peripher or Diameter giuen, how to finde out the whole peripher and Diameter both.

Therefore in this kinde of working you muſt either haue the Circumference or the Diameter giuen, or elſe ſome part of the one of them.

Firſt, let the whole diameter be giuen A B, which ſet ouer in 7 and 7 equall parts on the outer ſide both legges; the legges ſo reſting, take the diſtance with your compaſſe betwixt 5 ½ and 5 ½: then the diameter A B, and the length of that line laſt taken B C, are two lines, of which you may make an oblonge, by erecting B C perpendicular vpon one of the extremes of A B; or for the ſpeedy caſting vp of the contents, meaſure with your Compaſſe and Scale the length of thoſe two lines A B, and B C, and then worke as in the 22 Chap. Prop. 2, or Chapter 25.

Now if you deſire the right extenſion of the Circumference A R B N, the legges reſting at the diſtance they were, with your Compaſſe take the diſtance ouer in each legge betwixt 22 and 22, ſo ſhall you haue the line E I your demaund.

If you pleaſe, or if the numbers of 7 and 7, and 5 ½ and 5 ½ fall too neere the center, you may take 14 and 14, and 11 and 11, and all ſhall be one.

Secondly, if you haue but the Semidiameter of a circle giuen, as B E, ſet the length of that line ouer in 3 ½ equall parts on both legges: but becauſe thoſe parts fall too neere the center, ſet the line E B ouer in 14 equall parts in both legges, and then take the diſtance betwixt 44 and 44, ſo ſhall you haue the line E G: now it reſteth at your pleaſure whether you will make an oblonge thereof, as E G F B, or caſt it vp, as in the laſt Metamor.

Thirdly, you may happen to haue but the halfe Semidiameter H E giuen, which ſet ouer in 7 and 7 equall parts, or in 14 and 14, and then take the diſtance ouer in 88 and 88, or in 176 and 176, and note that line downe I E, for the other ſide of the oblonge; then you may either make an oblonge E F K H, or ſpeedily caſt it vp, as in the firſt Metamorp.

Fourthly, if you haue onely the Circumference E I giuen, ſet that diſtance ouer in 88, and then take with your compaſſe the diſtance betwixt 7 and 7, and note that line downe E H; then with theſe two lines worke as before.

Fiftly, if you haue onely the Semicircumference giuen, and be required to find the true Area of the circle, ſet that line as E G ouer in 22 and 22 equall parts in each legge, taking the diſtance ouer betwixt 7 and 7, ſo ſhall you haue the line E B; then worke as before: for hereby haue you the ende and ſide of an oblonge.

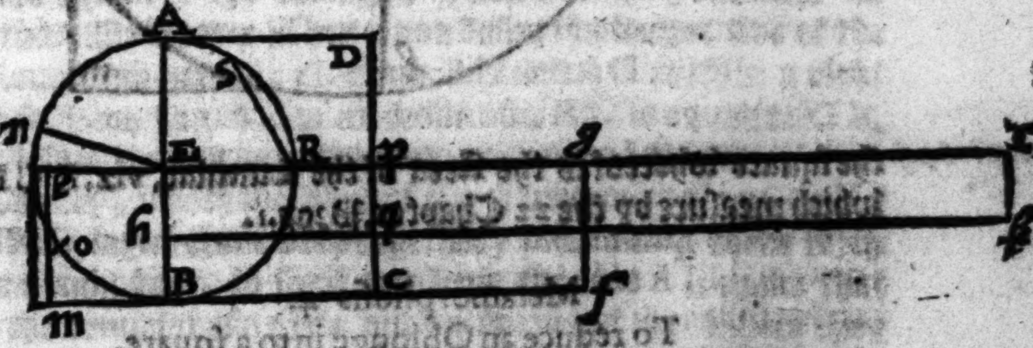
Sixtly, if you haue but the quarter of the Peripher, as E P giuen, ſet it ouer in 11 and 11 equall parts, and then take the diſtance ouer betwixt 14 and 14, ſo ſhall you haue the line A B, then worke as in the firſt Metamor.

Metamorphoſis 2.

To reduce the Sector of any circle into an Oblonge.

The Sector of a Circle is a ſegment contained inwardly under two right lines, making an angle in the center, the concourſe being called the baſe, as is proued.

Sector. Eu.l.3.p.9. Ra.l.16.p.3.



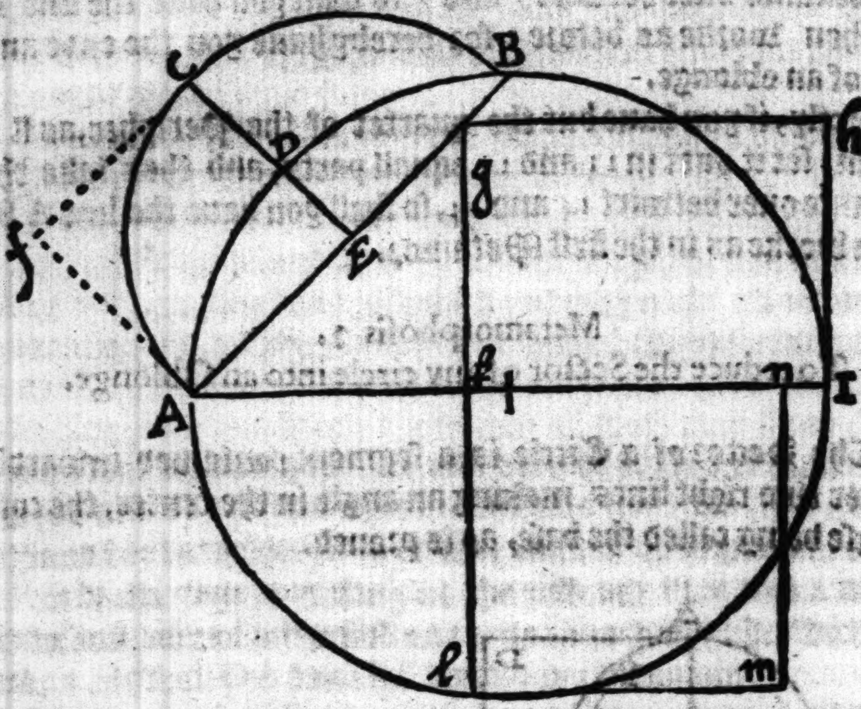
Then to make a right angled Parallelogram, the ſemidiameter, and halfe the ſegment are the two ſides thereof; and contrary, as the ſegment N E B is equall unto the oblonge L E B M, made of the ſemidiameter E B, and halfe the ſegment B O.

Or you may uſe halfe the Semidiameter, and the whole ſegment; ſo is E P the whole baſe of the ſector, and E H the halfe of the ſemidiametient E B, the two ſides of an oblonge E P Q H, equall to the ſector R E B.

Metamorphoſis 3.

To reduce a Lunular into a ſquare.

Let the Lunular be A B C D, then drawe the line A B, halfe



the ſquare whereof is the Area of the Lunular, viz. E C F B, which meaſure by the 22 Chapter, Prop. 1.

Metamorphoſis 4.

To reduce an Oblonge in to a ſquare.

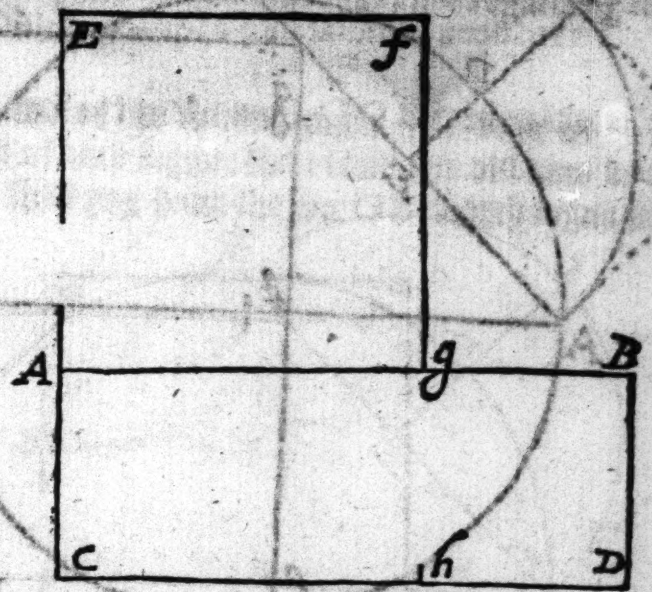
To performe this you muſt turne the ſides of the legges vpwards, which beare Chorde deuiſions, and then proceed thus.

In all Oblonges you ſhall either haue one ſide or two ſides giuen, and if you haue one ſide, it is either the longer or the ſhorter; and for either worke as followeth.

Firſt, let the greater ſide A B be giuen, which ſet ouer in 60, and 60 in each legge, then take the diſtance betwixt 36 and 36, and note that line downe A G; I ſay the ſquare made thereon is equall vnto the oblonge, viz. A E F G is equall to A B C D, as may be proued, * and that G B is the other ſide of the Oblonge B D vnknowne.

Eu. l. 6. p. 17. & l. 7. p. 20. Ra. l. 12. p. 4.

Secondly.



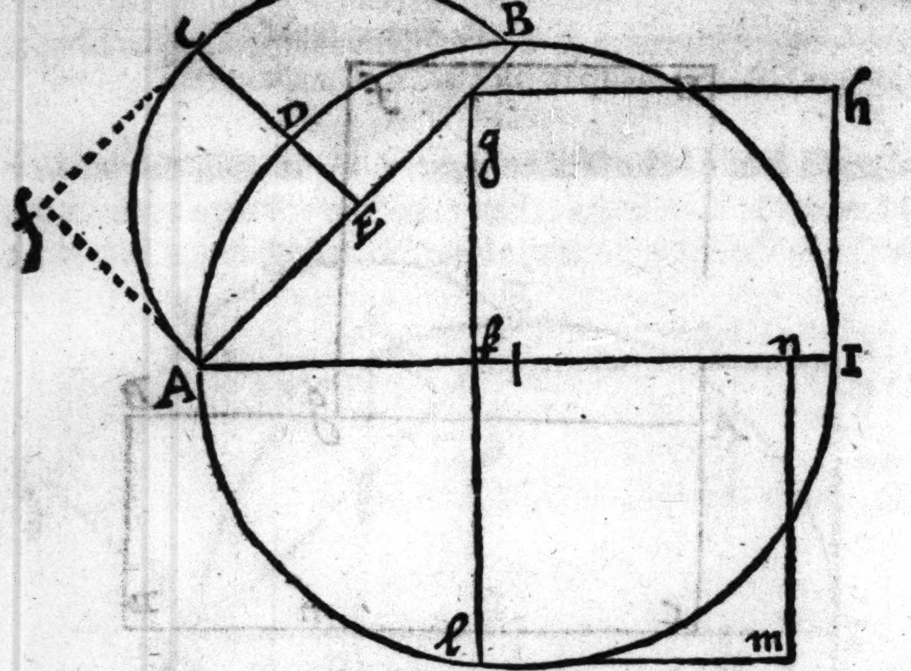
Secondly, if the ſhorter ſide B D be giuen, ſet that ouer in 36 and 36, and then take the diſtance betwixt 60 and 60, and note the length of that line name A G, which is the ſide of the ſquare equall to the oblonge, which you may meaſure as the third Metamorp. Then if you deſire the longer ſide of the Oblonge unknowne, continue B D and A G forth in a right line, ſo haue you A B your deſire: for B D is equall to G B, and A G is the meane proportion, as may be * proued.

Ra.l.18.p.8.

Thirdly, if both the ſides of the Oblonge be giuen, as K I and K G, ioyne them both together, continuing them forth in one right line, ſo ſhall you haue the line A I, make that line the diameter of a circle, and on the poynt K, where they were both ioyned together, raiſe a perpendicular to the circumference, as K L, which is the ſide of the ſquare K N M L, that is equall unto the oblonge K I H G, as may be proued.

Ro.l.6.p.23.
Ra l.16.p.19.

And in the ſame manner that you found K L, ſo ſhall you find out the meane proportionall of any two lines propoſed: therefore note this difference well.

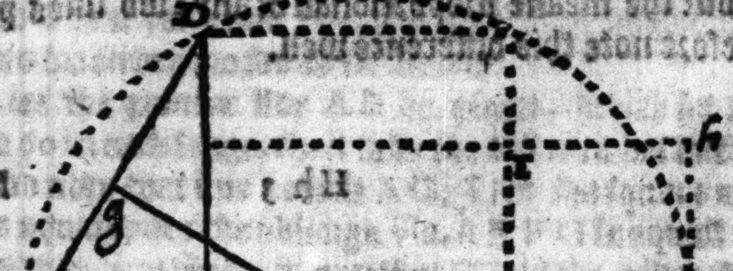


Metamorphoſis 5.

The one ſide of an Oblonge, and the ſide of a ſquare being giuen, to find the other ſide of the Oblonge, that is, to reduce a ſquare into an Oblonge, to containe the iuſt height of the Oblonge propoſed.

To reduce a ſquare into an Oblonge,

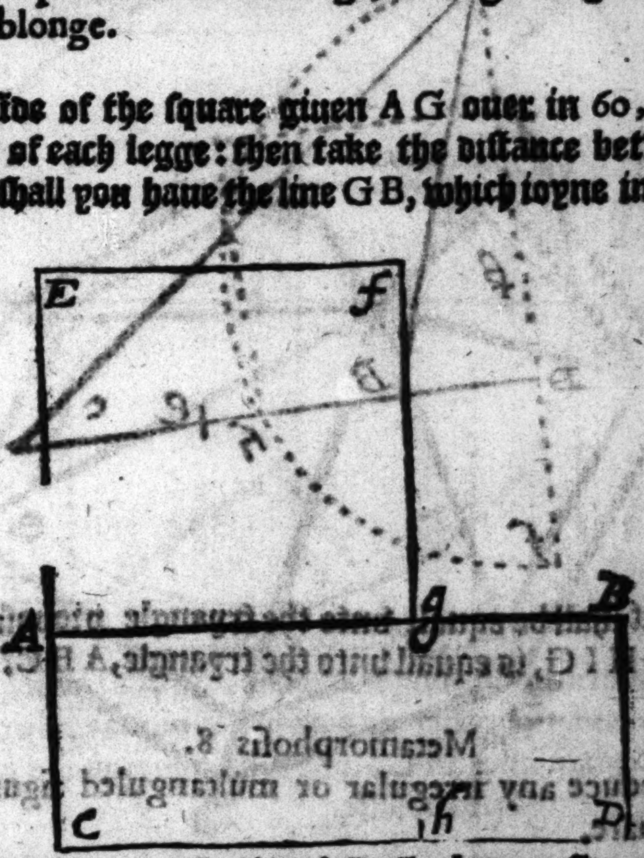
LEt A B be the ſhorter ſide of the Oblonge propoſed, which continue forth at pleaſure, as to E; then on the poynt B raiſe the perpendicular B D equall in height to the ſide of the giuen ſquare, then from D to A draw the line D A, in the middeſt whereof as at G, raiſe a perpendicular, and note where it interſects with the line AE, as at F, then making F a center, with the length of A F deſcribe a circle, which ſhall cut the point A and D, and alſo the line A E, as at E; ſo is D E the other ſide of the oblonge; note this propoſition, for it will be in ſingular vſe hereafter.



Metamorphoſis 6.

To reduce a ſquare into an Oblonge, not regarding the height of the Oblonge.

SEt the ſide of the ſquare giuen A G ouer in 60, and 60 Chords of each legge: then take the diſtance betwixt 36 and 36, ſo ſhall you haue the line G B, which ioyne in a right with A G: ſo haue you the line A B, the longer ſide of the oblonge: now to finde the other, I ſay it is already found; for B G is your demaund, to which B D is made equall: ſo haue you A B D C an oblonge equall to A E F G, the ſquare which was required.



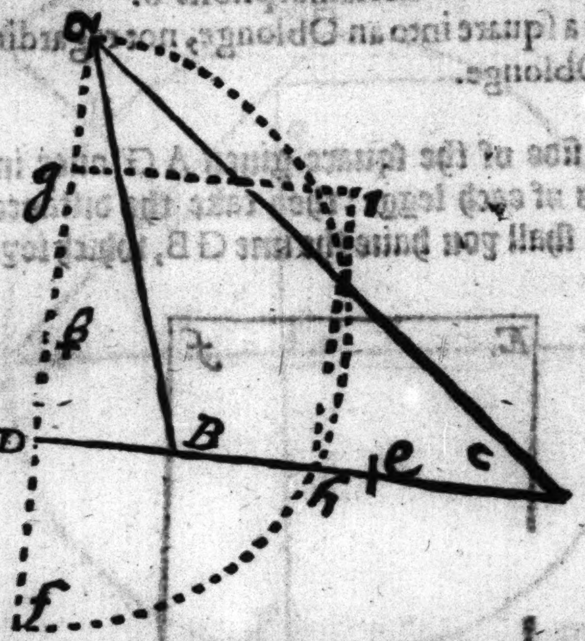
Metamorphoſis 7.

To reduce a tryangle into a ſquare, and to find the meane proportion betwixt the perpendicular and the baſe of any tryangle.

To reduce a tryangle into a ſquare.

I Would make a ſquare equall unto the tryangle A B C: Firſt I continue forth ỹ ſide B C infinite, as to D, and from A the top of the tryangle, I let fall the perpendicular A D on the line D C: then thus I firſt finde the meane proportion, to A D I adde halfe B C, as B E, which I continue forth in a right line, ſo that the continuation D F be equall to B E: then making A F the diameter of a circle upon K the center thereof, I deſcribe a halfe peripher, F H I A: ſo is D H the meane proportion, as may be proued:* which if you make the ſide of a ſquare,

Ro.l.6 p.13.
Ro.l.16.p.19.



ſquare, it ſhall be equall vnto the tryangle propoſed, as the ſquare D H I G, is equall vnto the tryangle, A B C.

Metamorphoſis 8.

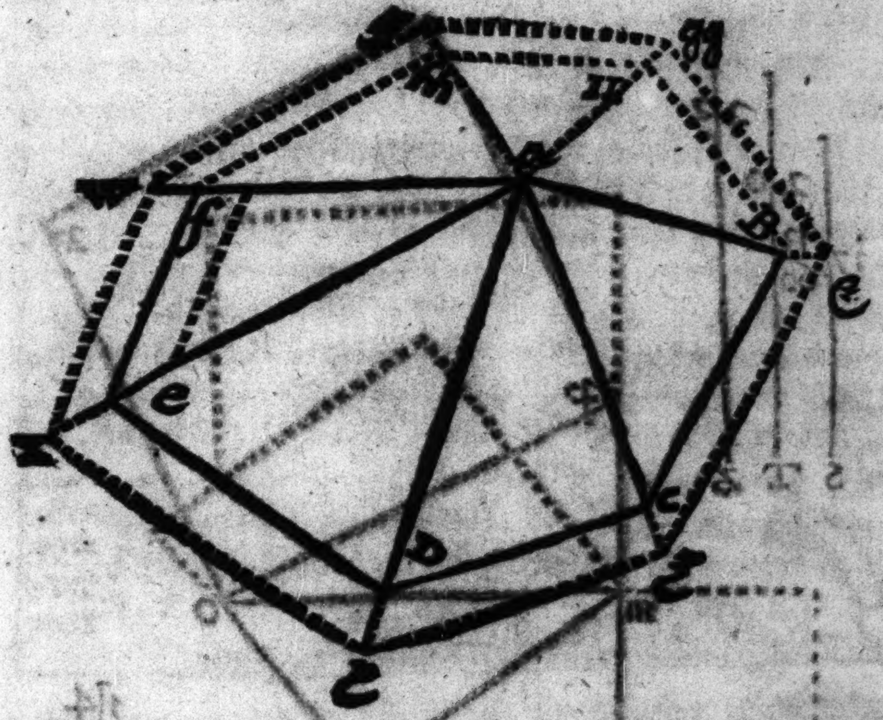
To reduce any irregular or multanguled figure into one ſquare.

To ſquare any irregular Polygonon.

This is alſo performed by finding the meane proportion or ſquare of each tryangle, and of all other is moſt neceſſary: for becauſe you ſhall hardly find any figure but he may be reſolued into tryangles, and ſo conſequently all thoſe for their ſpeedy meaſuring, may bee reduced into one entire ſquare.

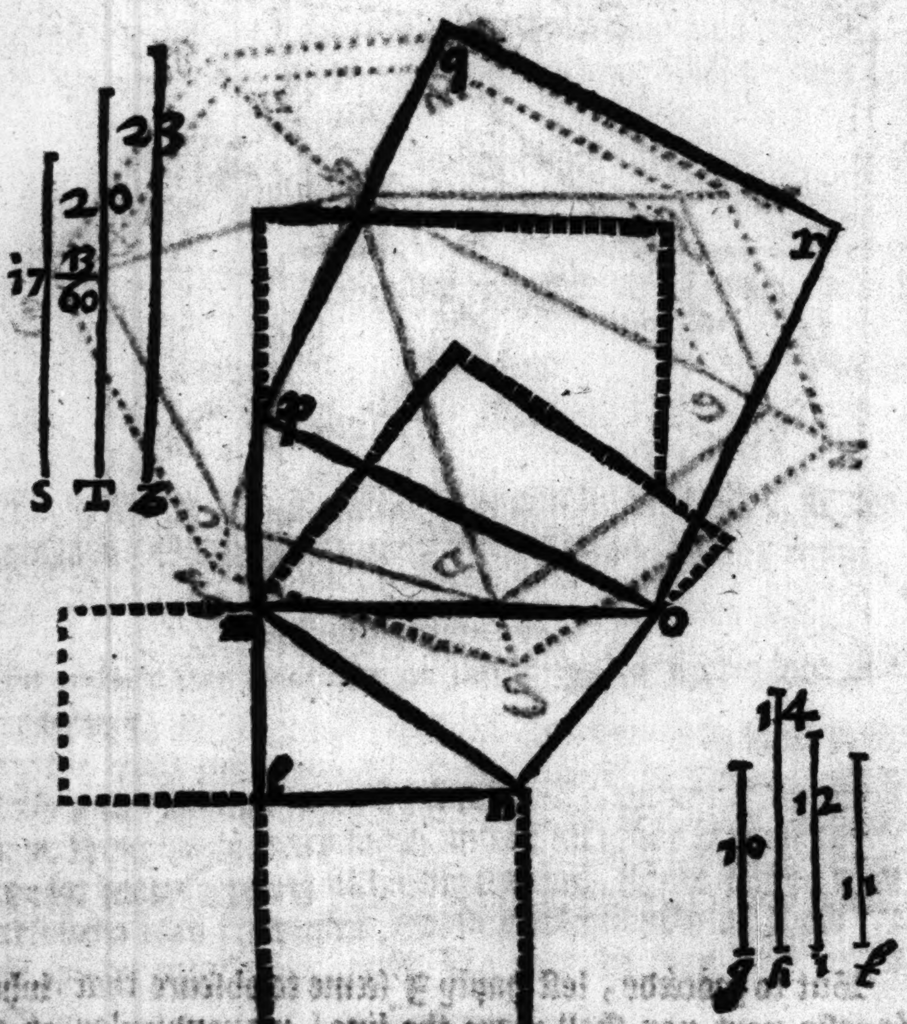
Let the figure be an Hexagon, as A B C D E F, which muſt be reſolued into foure tryangles, as in the end of the 8 Chapter, and as you ſee; then by the 7 Metamorphoſis finde the ſquare or meane proportion of each tryangle, ſo ſhall you finde the line G to be the ſquare of A E F H, the ſquare of A D E, I of A C D, and K of A B C: then reare G perpendicular vpon the extreames of H, as L M on L N, the Hipothenuſall M N, is the ſide of a ſquare equall to the two firſt tryangles F and E: ſo as if your figure had bene a Trapeza, it had bene finiſhed; for the ſquare made vpon M N, is equall to the ſquare of M L, and L N, as the pricked lines ſhew, and as may be proued, Euc. lib. 1. Prop. 47. 48. & 6. Prop. 31. Ra. l. 12. Prop. 5.

But



But to proceede, leſt haply I ſeeme to obſcure that which is eaſie, next you ſhall reare the line I perpendicular on the extreme of MN, as MNO: then the hypothenuſall OM is the ſide of a ſquare equall vnto the three Tryangles FE and D, as you may perceiue by helpe of the pricked lines. Laſtly, on the extreme of OM, raiſe K perpendicular, as MP, I conclude, the ſquare made vpon the hypothenuſall PO, is equall vnto the whole Hexagon, as PORG, is equall vnto ABCDEF: and thus might you haue proceeded vnto an Heptagon, an Octagon, Ennagon, Decagon, or any kind of multanguled figure: and thereby find one line, which multiplied in himſelfe, ſhould produce the ſuperficiall content of any field, Lordſhip, or Countrey, as for the purpoſe.

It It


q
r
p
o
m
f
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S
T
Z
17 13/60
20
23
14
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11
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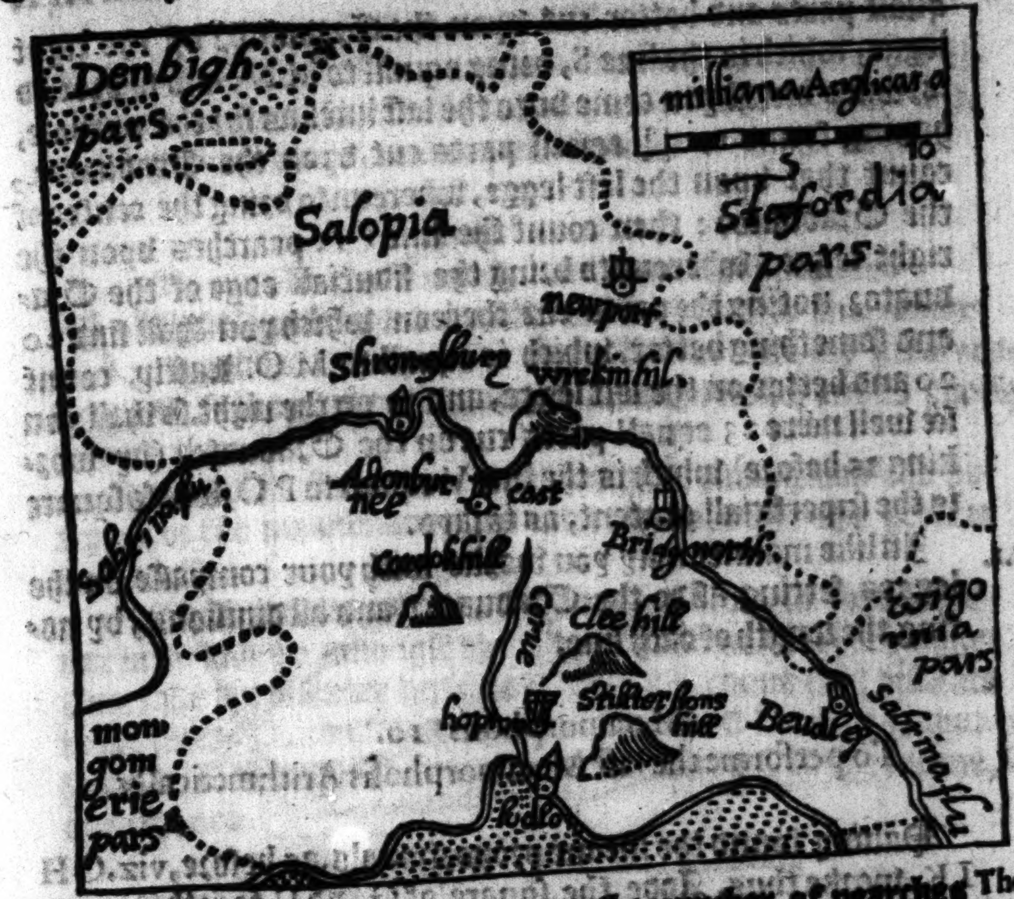
g
h
i
k

The ſquare or meane proportion of the County of Salop.

If you worke according unto the doctrine before ſayd, you ſhall find the meane proportionall of the County of Salop, to containe 28 of our Engliſh miles, whoſe ſquare is 784 miles; which augment by the ſquare of 320, viz. by 102400, and


Denbigh pars
milliaria Anglicana
5
10
Salopia
Staffordia pars
newport
Shrowsbury
wrekin hil.
Salrina flu
Actonbur nel
cast
Bridgnorth
Caradoc hill
Corve
clee hill
Wigornia pars
hopton
Stitterstons hill
Beudley
Sabrina flu
mongomerie pars
ludlo

and there is produced 80,281,600, the number of pearches in the County of Salop, which by reduction vnto ſtatute meaſure, according vnto the 24 Chapter, you ſhall find there amounts in the County of Salop 501760 acres, if it were plaine: but it is not preciſe, by reaſon it was taken from a ſmall Scale.

The number of pearches in Salop.

Number of acres in Salop.

Metamorphoſis 9.

To performe the laſt Metamorphoſis inſtrumentally.

Having found out the ſquare of each triangle, you may performe this Metamorphoſis eaſily by your ſtaffe thus, drawing no figure at all.

Open the legges vnto a right angle, for which purpoſe there is a hole neere vnto the center, to put through a ſcrew pin, and ſo ſtay the legges at a right angle; then ſhall you count the line G 10 pearches vpon the left legge, whereunto bring the center of the Graduator, and faſten him there; then vpon the right legge count the line H 14 pearches, whereunto bring the fiduciall edge of the Graduator; ſo ſhall you find $17\frac{13}{60}$ equall parts and better cut upon the Graduator by the right legge, which is the line S, being equall to M N; and ſo proceed forward untill you come unto the laſt line: as for the purpoſe, having found 17 $\frac{13}{60}$ equall parts cut upon the Graduator, count that upon the left legge, whereunto bring the center of the Graduator: then count the line I 12 pearches upon the right legge, whereunto bring the fiduciall edge of the Graduator, noting the parts cut thereon, which you ſhall find 20 and ſomething better, which is equall to M O. Laſtly, count 20 and better on the left legge, and 12 on the right, ſo ſhall you ſee well neere 23 equall parts cut on the Graduator (by working as before) which is the line V equall to P O, whoſe ſquare is the ſuperficiall content, as is ſayd.

Chap.25.Pt.1. In like manner may you worke with your compaſſe on the legges, ſetting aſide the Graduator, and all diviſions, by noting the length of each line.

Metamorphoſis 10.

To performe the laſt Metamorphoſis Arithmetically.

Having found the meane proportionals, as before, viz. G H I K, worke thus. Adde the ſquare of G and H together, and note the Radix by the 17 Chapter, then adde the ſquare of that Radix to the ſquare of I, and note againe the Radix quadrature, the ſquare whereof added to the ſquare of K, produceth a number, whoſe ſquare roote is the true ſquare of the Hexagon, whoſe ſquare is the contents.

Example:

The ſquare of G is 100, and of H 196, which added together maketh 296, whoſe Radix is 17 $\frac{13}{60}$, the ſquare whereof muſt be added to the ſquare of I, as 289 $\frac{169}{600}$ to 144, there riſeth 433 $\frac{169}{3600}$, whoſe ſquare muſt be added to the ſquare of K; ſo have you the contents, the radix quadrature being the ſide of the ſayd ſquare, as P O.

Chap. XLV.

Of the proportion of lines and numbers one to another, with the deuiding of lines, without the knowledge whereof it is not poſſible for any to be a perfect Surueyor or Geodetor.

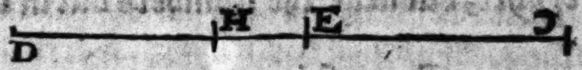
Propoſition 1.

To cut a line by extreme and meane proportion.

A Right line is ſayd to be deuided by extreme and meane proportion, when, as the whole ſhall be vnto the greater ſegment, ſo the greater ſegment is vnto the leſſer; and is performed thus. Eu.l.6.p.3. Ra.l.14.p.1.

You muſt firſt conſider whether you haue giuen the extreme or the meane: and if the extreme, whether the greater or the leſſe.

1. If the greater extreme be giuen, as C D, ſit that line ouer in 60 and 60 amongſt the Chord diuiſions on each legge; then take the diſtance betwixt 36 and 36; count that diſtance in the line C D, as C H. I conclude, the line C D is cut proportionally, C D and H D being the extremes, & C H the meane, as is proued. Metamor. 4. Def.1.



2. If the leſſer extreme be giuen, as H D, ſit that line in 36 and 36 among the Chord diuiſions in each legge, and then take the diſtance ouer in 60 and 60, and note that line downe C H, which continue forth in a right line: ſo ſhall you haue C D the greater extreme, and C H the meane, as is proued Metamorphoſis 4, Defi. 2.

3. If the meane be giuen, and both the extremes required, worke as in the 4 Metamorphoſis, Def. 3.

Propoſition 2.

Two numbers being giuen, to find two lines which ſhall haue ſuch proportion one to the other, as the numbers giuen haue.

This kind of working is grounded vpon this Geometricall Propoſition:

Si recta in triangulo eſt parallela baſi, ſecat crura proportionaliter, & contra, Eucl.l.3.Prop.32. Ra.l.6.p.9.

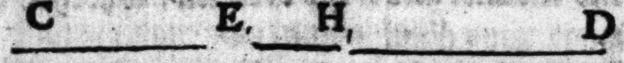
In this kinde of working we ſhall not altogether digreſſe from D. Hood in his Sector, whoſe many labours deſerue to Proportion of numbers to lines.

be eterniƷed.

Conſider if the two numbers giuen be vnder or aboue 19, if they be both vnder 19, ioyne a cypher on the right hand, and then open the legges vnto what angle you pleaſe, ſeeking thoſe two numbers in the legges; and then the diſtance with your Compaſſe taken ouer from number to number, yeeldeth the proportionall lines.

Example.

Let the numbers be 13 and 6, I ioyne a cypher to 13, and make it 130, and to 6, making it 60; then I open the legges, as I ſee cauſe, and take the diſtance ouer betwixt 130, and 130 equall parts in each legge, and note that line C D: the legges ſo reſting, take the diſtance betwixt 60 and 60, and note that line downe C E; ſo haue you two lines, viz. C D and C E, in ſuch proportion one to the other, as 6 is to 13, or as 60 is to 130.



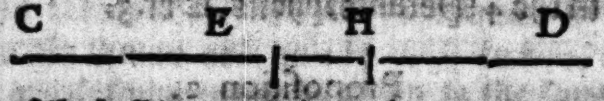
2. If either of the two proportionall numbers be aboue 19, ioyne no cypher, but ſeeke the numbers out in the legges, as before.

Propoſition 3.

A line being giuen, and a proportion aſſigned, to lay downe a line, which ſhall be to the line giuen in ſuch proportion as was aſſigned.

Proportion of lines.

I haue a line giuen C E, and am required to lay downe a line that ſhall beare ſuch proportion vnto C E, as 13 doth to 6; by the doctrine of the laſt Propoſition I ioyne a cypher vnto the two numbers giuen, ſo be they 130 and 60: ſit the line giuen C E ouer in 60 equall parts of each legge, and then take the diſtance ouer from 130 to 130; ſo ſhall you haue the line C D, which is the line that is vnto C E, as 13 to 6.



Note.

In this kind of working you muſt call the firſt number the antecedent, and the latter the conſequence, and you muſt ſee whether the antecedent or conſequent be greater: If the antecedent be the greater, you may conclude that the line ſought for is greater then the line giuen, and that the line giuen muſt be applied to the leſſer number: becauſe I ſeeke for a greater line, as 13 is to 6: here 13 the antecedent is greater then 6 the conſequence: therefore the line ſought for is greater then the line giuen, and muſt be fitted in 6 and 6, and the line ſought taken from 13 to 13.

If the conſequence excéede the antecedent, then the line ſought for is leſſer then the line giuen, and the line giuen muſt be applied to the greater number, becauſe I ſéeke for a leſſer line. Or thus briefly according to the preſcript.

The	Antecedent	being Maior, apply the giuen line to the	leſſer number.
	Conſequent		greater number.

Propoſition 4.

Two lines being giuen, to find what proportion the one hath to the other.

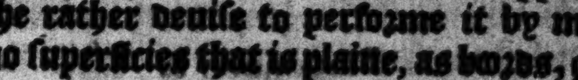
What propor-tion lines haue among them-ſelues.

In this Art of Geodetia you ſhall find this propoſition to be no leſſe requiſite then the reſt, as hereafter appeares, which made me the rather deuiſe to performe it by my ſtaffe: for there ſhall no ſuperficies that is plaine, as boords, glaſſe, pauements, paſtures, &c. happen, but by this Propoſition you ſhall ſpéedily find what proportion the one hath vnto the other: but ſetting aſide amplifications, let vs returne vnto the purpoſe.

Fit the longer of the two lines giuen ouer in any number of equall diuiſions what you will: the legges ſo reſting, with your Compaſſe take the length of the ſhorter line, and bring that along the graduation of the equall diuiſions, vntill you haue fit it ouer in like parts on both legges; which done, you may conclude that the parts wherein the feete of your Compaſſe then ſtand, and the parts wherein you placed the longer line, be in proportion one to the other, as the lines propoſed be.

Example.

I haue two lines C D and C E giuen, and am required to ſhew what proportion the one beareth vnto the other.



Firſt I fit C D ouer in 130 equall parts on both legges, then I bring the length of C E along the graduation of equall diuiſions, vntill the feete of my Compaſſes cut equall parts in both legges, which will fall out at 60: I conclude C D is in ſuch pꝛopoꝛtion to C E, as 130 is to 60.

Propoſition 5.

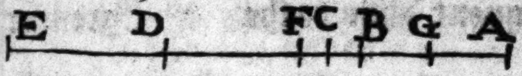
To denide a line into any number of equall parts propoſed.

To deuide a line into any number of equall parts.

Fit the line giuen ouer in the number of parts, into which you would deuide the ſame, and then take the diſtance ouer from diuiſion vnto diuiſion, ſo haue you your deſire.

Example.

I would deuide an inch into 20 equall parts. Let B E be the inch, which fit ouer in 20 and 20 of each legge; then take the diſtance from 19 to 19, which apply to the line B E, as to C from E: ſo haue you B C, which ſet 20 times, deuideth B E into 20 equall parts: oꝛ elſe pꝛocéede downewards along the graduation, taking the diſtance from number to number, and applying it to the line, as from 18 to 18, ſo haue you the line F E, &c.

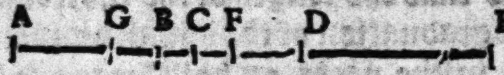


Propoſition 6.

A line being giuen to deliuer any part thereof.

To deliuer any part of a line.

I haue a line A E giuen, and am required to deliuer a third part thereof: to auoide Arithmeticke, chuſe ſome number which you may deuide into thꝛée equall parts, as 60: therefoꝛe fit A E ouer in 60 and 60 equall parts on both legges.



Then becauſe 20 is the third part of 60, I take the diſtance betwixt 20 and 20, ſo applying that diſtance to A E I haue A B, a third part of A E: if you would haue found $\frac{2}{3}$, you muſt haue taken the diſtance ouer from 40 to 40, ſo ſhould you haue found the line A D, your deſire.

Or thus Arithmetically.

Fit the length of the line giuen, as A E ouer in any number of equall parts, as in 60 and 60, which deuide by the parts of the line required, which let be the ſixt part: 60 deuided by 6, yeeldeth 10: therefoꝛe I take the diſtance betwixt 10 and 10 in both legges: ſo haue I the line A G, which is contained 6 times in A E, and ſo often is 10 in 60.

Chap.

Chap. XLVI.

Of finding of the proportion that one figure or peece of ground, &c. hath to another, to finde out the Diameter of a circle, or any chorde or ſide of any regular figure, the circumference being vnknowne, to deuide a circle, and finde the proportion of any chorde vnto the circumference.

Propoſition 1.

Two figures or two peeces of ground being giuen, to finde what proportion the one hath to the other.

What proportion any two figures one hath to the other.

Either the figures propoſed be all ſquares or oblonges, &c. or one a ſquare, the other an oblonge or a multangled, &c. and for either worke thus. Reduce the two figures into two parallelograms of equall height, then by the 45 Chapter, Pro. 4, find what proportion their baſes haue one to the other: for ſuch haue the figures, as is proued *.

Eu. l. 6. p. 1.
Ra. l. 10. p. 13.

Example.

Let the one figure be a circle, and the other a multangle, by the firſt Metamorp. I reduce the circle into an oblonge, then by the 7 Metamorp. I reduce the multangle into a ſquare. Laſtly, by the 5 Metamorp. I reduce the ſquare into an oblonge, equall in height to the oblonge made of the circle. I conclude by the 45 Chapter Prop. 4, that ſuch proportion as their baſes haue the one to the other, the like hath the figures, viz. the circle and the multangle one to the other.

In the ſame maner may you deale with pauements, flores, bords, glaſſe, &c.

Propoſition 2.

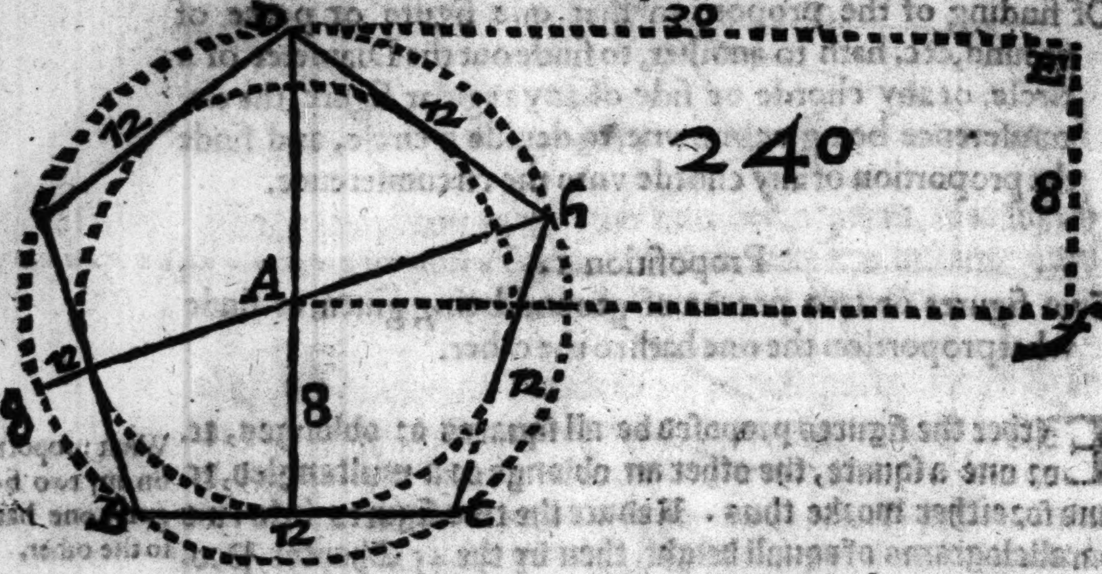
Any chord of a circle being giuen, to find the diameter of a circle, to which the inſcription of the chorde ſhall anſwer.

To find the diameter of any circle.

To performe this propoſition, you muſt turne the chorde diuiſions vpon the legges vpwards, and then ſit the length of the chord in the parts of each legge anſwering thereunto, the diſtance then taken betwixt the two poynts reſpectiue, or from 60 to 60, yeeldeth the iuſt length of the ſemidiameter, which doubled is the diameter.

Or ſit the chorde giuen ouer in the number anſwering to the halfe thereof, the diſtance then betwixt 60 and 60 is the diameter.

Example.



I haue B C the ſide of a pentagon giuen, and am required to deliuer the diameter of the circle wherein the pentagon or figure of fiue ſides may be inſcribed: fit therefore the ſide of the pentagon B C ouer in 72 and 72 parts of each legge, which are marked with this letter P to ſignifie a pentagon, and then take the diſtance from 60 to 60, which double; ſo haue you your deſire G H.

And by this meanes the chorde of a circle being giuen, you may find out the center.

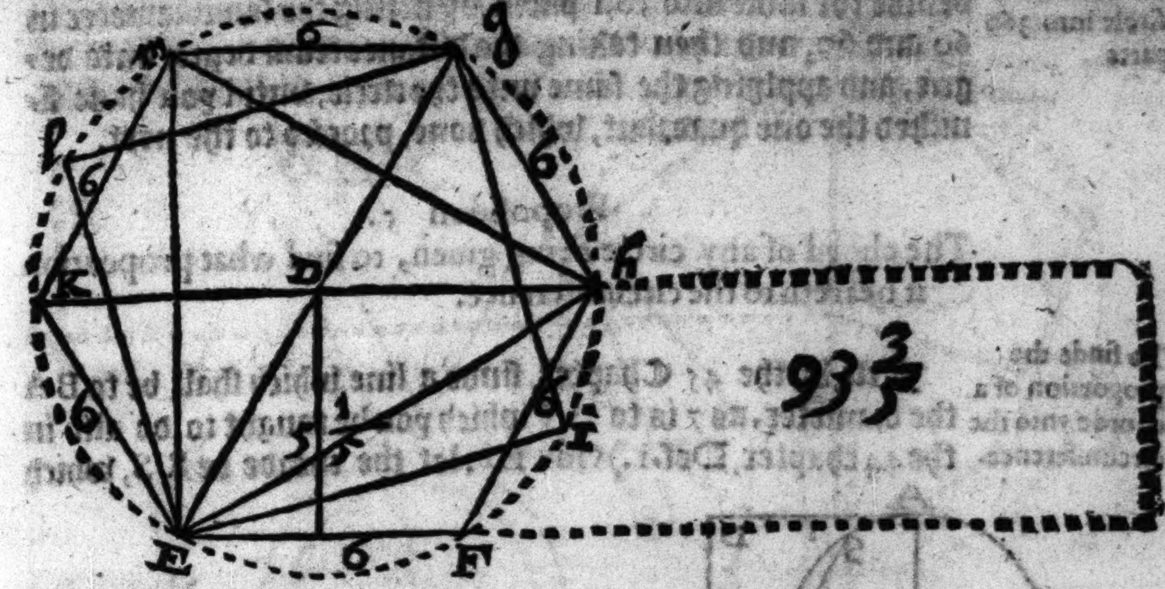
Propoſition 3.

Alſo the diameter being giuen, you may inſcribe an equilater tryangle, a ſquare, a pentagon, an hexagon, &c. by fitting the ſemidiameter ouer in 60 in each legge amongſt the chorde diuiſions, and then take the diſtance ouer from number to number in each legge marked with the letter K anſwering thereunto.

Example.

I would find the ſide of an hexagon, that might be inſcribed within the circle E G F, the ſemidiameter E D being giuen, fit E D ouer in 60 and 60, then becauſe 60 and 60 on the legges is marked with an H, ſignifying an hexagon, you haue your demaund, which fit 6 times in the circumference, ſo will E F one of the equilaters be equall to D E the ſemidiameter.

2 But if you would inſcribe a ſquare, hauing fitted D E in 60 and 60, take the diſtance from 90 to 90, marked with S Q.



to ſignifie a ſquare, ſo ſhall you haue D I, which may be ſet foure times in the circumference, as E I G L.

Or hauing fitted the ſemidiameter in 60 and 60, worke thus in numbers.

For the ſide of	a ſquare	to take ẏ diſtance auer betwixt	90	degrees in each legge.
	a pentagon		72	
	an hexagon		60	
	an heptagon		51. 20 ferè	
	an octagon		45	
	an eneagon		40	
	a decagon		36	

To finde the ſide of an equilater tryangle, you muſt put the ſide of an hexagon twice in the circumference, ſo ſhall you inſcribe the tryangle E H M. Whereby vpon a neceſſary conſequence it followeth.

that hauing ẏ ſide of	an Eq. tryangle	by deuiding and ſubdeuiding, we may finde ẏ ſide of figures hauing	6.12.48.96.	ſides.
	a Square		8.16.32.64.128	
	a Pentagon		10.20.40.80.160	
	an Hexagon		as a tryangle	
	an Heptagon		14.28.56.112.	
	an Octagon		as a ſquare	
	an Eneagon		18.36.72	
	a Decagon,		as a pentagon	

Propoſition 4.

Alſo hauing the ſemidiameter of any circle, you may eaſily

deuiſe

To deuide any circle into 360 parts.

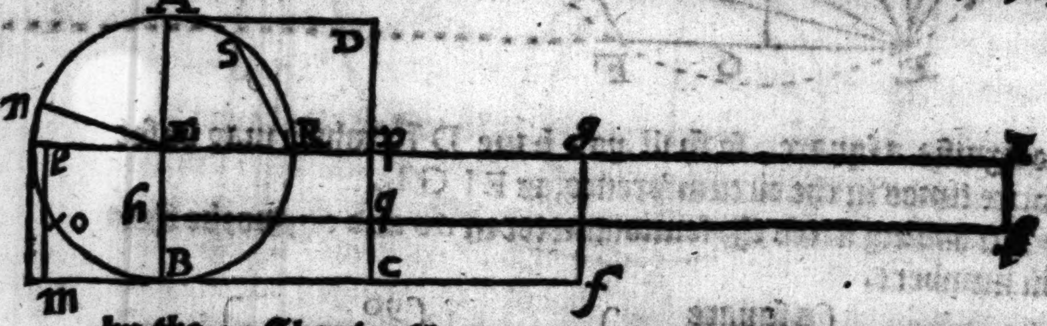
deuide the ſame into 360 parts, by fitting the ſemidiameter in 60 and 60, and then taking the diſtance from degree vnto degree, and applying the ſame vnto the circle, vntill you haue finiſhed the one quadrant, which done, proceed to the next.

Propoſition 5.

The chord of any circle being giuen, to find what proportion it beareth to the circumference.

To finde the proportion of a chorde vnto the circumference.

Firſt, by the 45 Chapter, finde a line which ſhall be to B A the diameter, as 7 is to 22 (which you be taught to do alſo in the 44 chapter, Def.1.) vide E I; let the chorde be R S, which



by the 45 Chapter, Prop.4, you may eaſily find what proportion R S hath to E I.

Propoſition 6.

To find a right line equal to any aſſigned arke of a circle.

Of the right extenſion of any arke.

As 360 is to ÿ arke giuen, ſo is the line of the right extenſion of the circumference to the line required: vnderſtanding the premiſes, this is eaſie.

Chap. XLVII.

Of the making of any figure like and proportionall to any figure aſſigned, with a further diſcourſe of deuiding all maner of grounds.

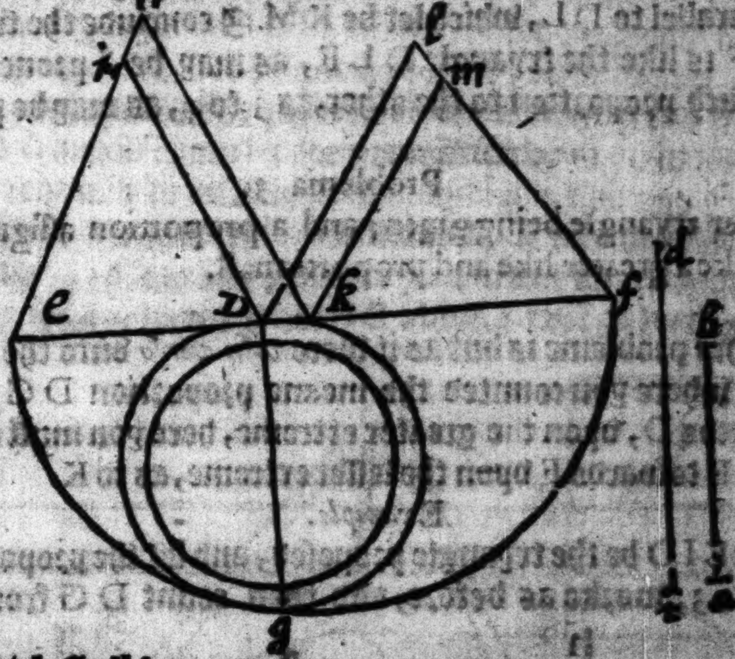
Propoſition 1.

A circle being giuen, and a proportion aſſigned, to deliuer a circle anſwering to the Symmetry thereof, and the proportion aſſigned.

All circles be like one vnto another, and as for the proportion, worke thus.

Becauſe there can no figure be made proportionall vnto any aſſigned figure, vnleſſe ſome line be giuen to make the ſame vpon: therefore in all circles take their diameter, which let be A B; then by the 45 Chapter, Prop. 3, ſeeke a

To make a circle according to any proportion.



line which ſhall be to the Diameter A B, according as the proportion was aſſigned, viz. as 4 to 3, which let be C D: ioyne thoſe two lines together in the poynt D, and let them be continued foorth in a right line F F, which make the diameter of a circle E G F: then vpon the poynt D, where the two lines were ioyned, raiſe a perpendicular D G, to touch the circumference, as at G, at all aduentures: ſo is D G the diameter of a circle, whereon the circle muſt be made, as you may perceiue by the figure, where two circles be circumſcribed according vnto ẏ proportion aſſigned, as may be proued. *

* Ra.l. 16.p.19. Ra.l.6.p.13.

Problema. 2.

A greater tryangle being giuen, and a proportion aſſigned, to make a tryangle leſſer and like the greater, according to the proportion aſſigned.

Let the tryangle in the laſt probleme be D L F, take either of the ſides thereof, namely D F, which is equall to the line D C, let the proportion be as 3 is to 4, a ſubſeſquitertia: ſeeke therefore by the 3 prop. of the 45 Chapter, a line which ſhall beare ſuch proportion vnto C D, as 3 doth to 4, as B A; continue them in one right line E F, which make the diameter of

Deuiding of tryangles.

a circle, as in the laſt probleme: and where they were ioyned together, raiſe a perpendicular, as on D, which ſhall cut the circumference in G; then count the line D G in the line F D, from F towards D, as F K: then from the poynt K drawe a line parallel to D L, which let be K M. I conclude the tryangle K M F is like the tryangle D L F, as may be * proued, and hath ſuch proportion to the other, as 3 to 4, as may be proued.

Ra. l. 4. p. 14. Eu. l. 6 p. 2. & l. 6. pro. 4. & 5. Ra. l. 6. p. 8. & l. 7. p. 9.

Problema 3.

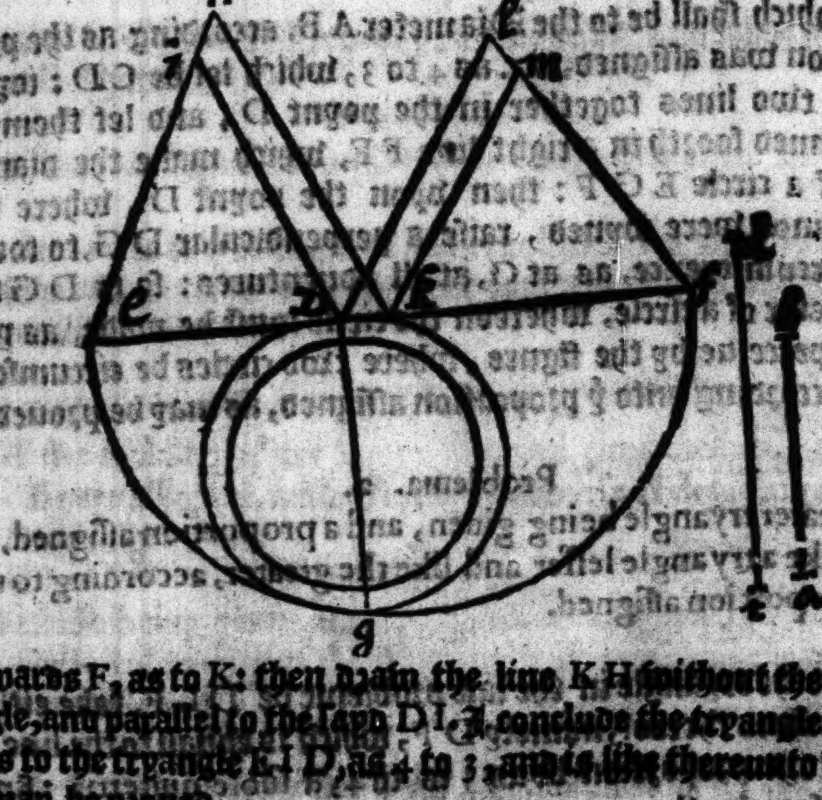
A leſſer tryangle being giuen, and a proportion aſſigned, to make a greater like and proportionall.

To make a tryangle according to any proportion.

This probleme is but as it were *viſu verſo* vnto the laſt, ſauing where you counted the meane proportion D G from F towards D, vpon the greater extreme, here you muſt count it from E towards F vpon the leſſer extreme, as to K.

Example.

Let E I D be the tryangle propoſed, and let the proportion be as 4 to 3, worke as before, and then count D G from E towards F, as to K: then drawe the line K H without the tryangle, and parallel to the ſayd D I. I conclude the tryangle E H D is to the tryangle E I D, as 4 to 3, and is like thereunto alſo, as may be proued.



Problema 4.

Prob.

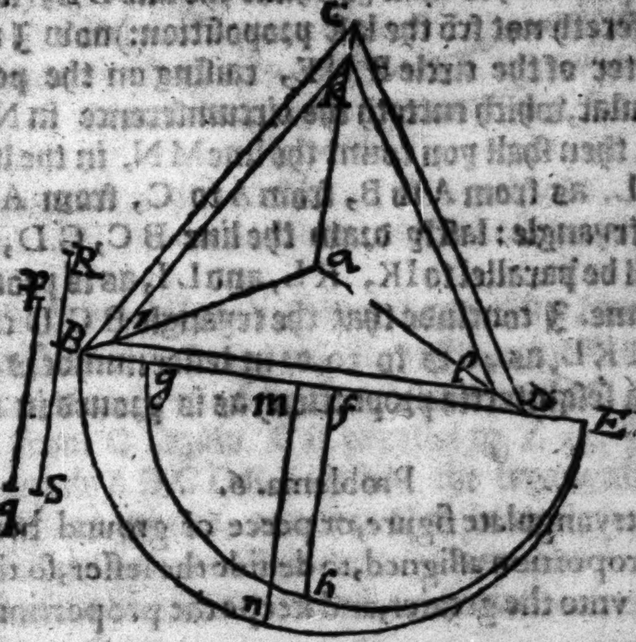
Problema 4.

To performe the ſecond prob. by drawing parallel lines about the tryangle.

Let the tryangle be B C D, whoſe center you muſt find by Euc.l.4.prop.5. or Ra.l.17.pro.5,* or as you be taught, which let be A; whence drawe right lines to each corner, as from A to B, to C and D; now let the propoſition be as 30 to 40, here you be requiredto inſcribe a leſſer tryangle, like and proportionall unto the greater B C D: take therefore the line A B, and by the 45 Chapter, Prop.3, find a line which ſhall be to A B as 30 to 40, which let be P Q and R S: ioyne P Q and R S

Cap.23.p.1.

To inſcribe a tryangle according to a proportion.



together at F, making one right line as G E, and let the poynt of connection be F; make E G the diameter of the circle G H E, then on the poynt F raiſe a perpendicular, which ſhall cut the circumference M H, then count F H M on the line A B, from A towards B, as to I, which line alſo count in the line A C and A D, as A K, and A L; then draw the line I K, K L, L I, which ſhall be parallel to B C, C D, and D B, as may be * proued. Then I conclude that the tryangle I K L is like the tryangle B C D, as may be proued, and that the tryangle I K L inſcribed is to B C D, as 30 to 40, as is alſo proued, Ra.l.4.prop.15. Conſ.1.

Eu.l.6 p.2.
Ra.l.6.p.8.
*Ra.l.4.p.14.&
lib.5.p.12.Conſ.
4.& l.7.p.9.
Eu.l.6.p.15.

Problema 5.

To performe the third propoſition, by drawing parallel lines about the figure.

This is not much differing from the laſt probleme, when you haue found out the proportionall lines.

Circumſcribing tryangles according to a proportion.

Let therefore the tryangle be I K L, finde the center thereof as in the laſt propoſition, whence draw the lines A I A, K, & A L infinitly, now let the proportion be as 40 to 30: firſt by the prealleged 45 Chapter, propoſition 3, find a line which ſhall be to A I, as 40 is to 30, which let be M E; to which annex A I, in the point M, ſo ſhall you haue the line B E, (ſo now the worke differeth not frō the laſt propoſition:) now I make B E the dyameter of the circle B N E, raiſing on the point M A perpendicular, which cutteth the circumference in N, at all aduentures; then ſhall you count the line M N, in the line A I, A K, and A L, as from A to B, from A to C, from A to D, beyond the tryangle: laſtly draw the line B C, C D, and D E, which ſhall be parallel to I K, K L, and L I, as is proued in the laſt probleme. I conclude that the tryangle B C D circumſcribed, is to I K L, as 40 is to 30, or in leſſer numbers, as 4 to 3 (which is a ſeſquitertia proportion) as is proued in the 4 probleme.

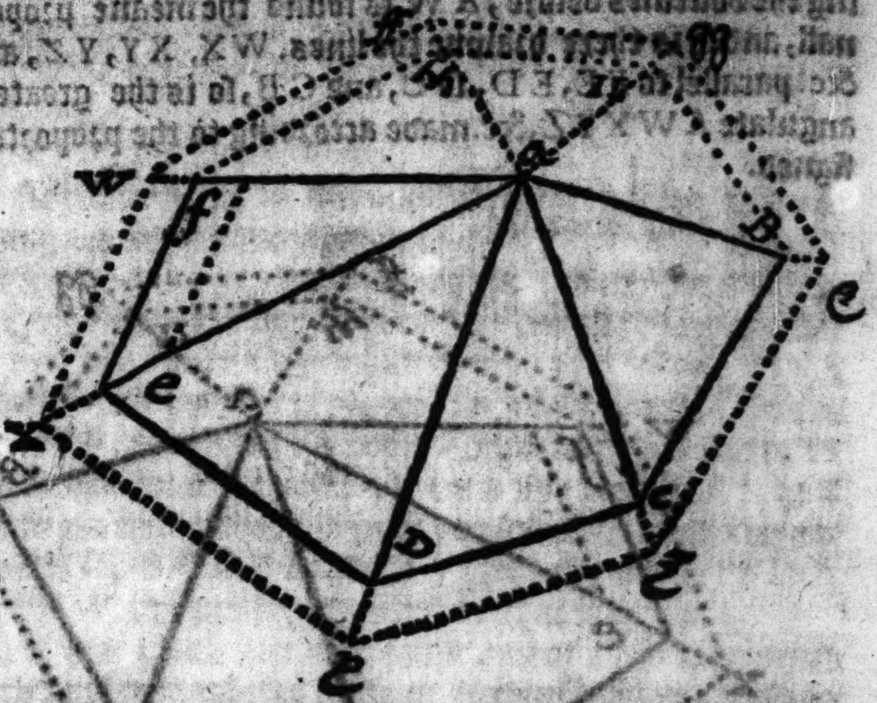
Problema. 6.

A greater tryangulate figure, or peece of ground being giuen, and a proportion aſſigned, to deuide the leſſer, ſo that he ſhal be like vnto the greater, and keepe the proportion aſſigned.

To deuide a tryangulate.

If this as in the former probleme, you be required to performe two things, that is to make a leſſer figure like to a figure aſſigned, and to retaine the proportion aſſigned,

Let the greater Tryangulate be A W X Y Z, &c. and let the prob. be to find a leſſer tryangulat that ſhall be to the greater as 3 to 4: firſt therefore from any one corner, as from A to each corner in the tryangulat draw ſtraight lines, as A X, A Y, A Z, then take any one ſide of the tryangulat containing the angle A, let it be A W, and by the 45 Chapter, propoſition 3, find a line which ſhall be to A W, as 3 is to 4: ioyne thoſe two lines together, as in the former probleme, making them the dyameter of a circle and ſo find out the meane proportional, which



ſount in the line A W, as A F: then draw a line from the point F parallel to W X as F E, and from the point E draw a line parallel to X Y as E D; from D draw a line D C parallel to Y Z, and from C draw C B parallel to Z &. I conclude the tryangulate A B C D E E, is like the tryangulate, A W X Y Z &, as * is proued, and that they beare ſuch proportion one to the other as was aſſigned, as alſo may be * be proued in the end of the ſecond and fourth probleme.

* Problema 4.

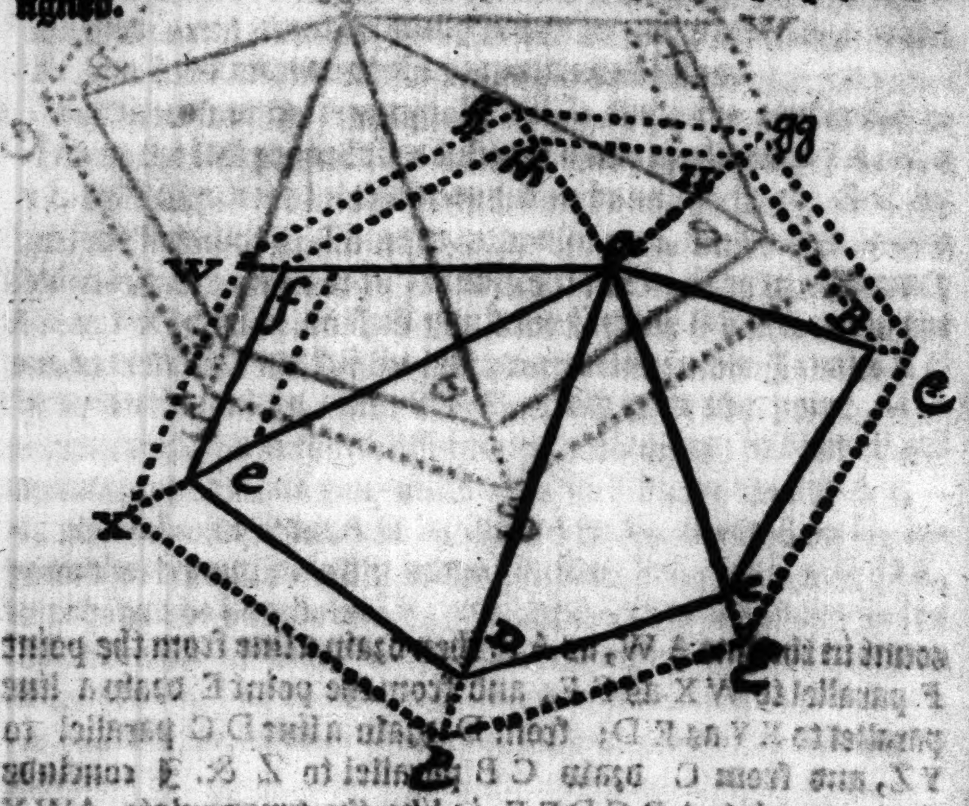
* Ra. l. 30. p. 22.

Problema 7.

A leſſer tryangulate being giuen and a proportion aſſigned, to deliuer a greater, like and proportionall to the leſſer.

To circumſcribe a tryangulate proportionall. 45. cap. p. 3.

If the leſſer be giuen, and the greater required, hauing found the lines by the preallegated prob: that haue ſuch proportion one unto the other as the numbers giuen haue, and then make them the diameter of a circle, and ſo found out the meane proportionall as before, the worke differeth not from the laſt probleme, ſauing that the lines muſt be drawne upon the utter ſide the figure, as before they were on the inſide: ſo is A F, the line giuen, and the proportion as 4 to 3; following the doctrines before, A W is found the meane proportionall, and ſo is there drawne the lines, W X, X Y, Y Z, and Z, &c. parallel to F E, E D, D C, and C B, ſo is the greater tryangulate A W X Y Z, &c. made according to the proportion aſſigned.



Problema 8.

A field of tryangulates being giuen, to inſcribe a tryangulate with parallel ſides according vnto the proportion aſſigned.

To inſcribe a tryangle.

The figures generally that may riſe in kinds of tryangulates be infinite, for that the ſeuerall kind of tryangles that may be packed together be infinite: for a tryangulat is nothing elſe but the aggregating of a certaine number of tryangles: for he is ſaid tryangulate, becauſe he is compoſed of tryangles, & may be reſolued therinto againe: but notwithſtanding their different formes, yet the order of inſcribing in one is common to all, whether they be quadrangles multangles or any ſuch kinde: and ſo I would haue you to vnderſtand that whatſoeuer I haue ſaid of any one figure before in particular, ÿ like is to be vnderſtood of all of like denomination in generall, as of tryangles, whether they be Iſoſceles or ſcalenums, &c. And to be ſhort, this worke, the premiſſes vnderſtood, differeth not from that is ſaid, but for the vnpractiſed Geometrician, whoſe cauſe I tender, I will not ceaſe to proſecute the ſame.

Let the multangle be FF GG, and Z Y X W, then make a point ſomewhere about the middeſt, as at A, from whence vnto each corner produce right lines, as A FF, A GG, A Y, A Z, and ſo round as you ſee in the figure (of the ſeventh problemes) then take any line, let it be A W, and let the proportion be as 3 to 4: finde a line which ſhall be to A W as 3 to 4, & ſo as before find the meane proportion, which count in the line A W, as A F. then from the point F draw a line parallel to W X, as F E, and from the point E draw a line parallel X Y, as E D, and ſo goe round about, ſo haue you inſcribed a leſſer tryangulate HH II, B C D E F, like and proportionall to FF GG, and Z Y X W, the greater tryangulate, that is as 3 to 4.

And if you pleaſe you may draw any of theſe forenamed tryangles or tryangulates without circumſcription or inſcription, according vnto any proportion aſſigned, onely by themſelues if you doe but note the angles, and make your proportion, the ground whereof you may gather by theſe propoſitions.

If parts like to the parts of a figure giuen, and in like manner ſituate, be placed vpon a terme giuen, there ſhall be placed vpon the ſame terme a figure, like to the figure giuen, & in like manner ſituate. Ra. L. 4. P. 14. Conſ. 4.

Like figures be figures equianguled proportionall in the ſeete of the equall angles. Ra. l. & proued before.

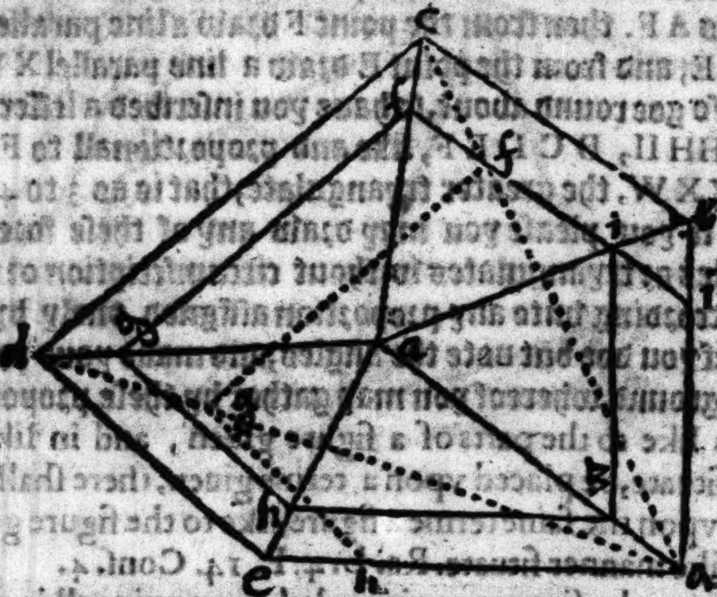
Problema 9.

Any kind of figure being giuen, and a proportion aſſigned, to make a figure which ſhall haue his ſides to the ſides of the figure giuen, in ſuch proportion as was required.

To make a figure proportionall in ſides to any figure.

Let the figure be A B C D E, and let the proportion be ſubſeſquitertia, as 30 to 40, by which proportion you may gather that the figure ſought is leſſe then the figure giuen.

Take therefore ſome point in the middeſt of the figure giuen, which let be A, from either of which points produce right lines vnto each corner in the peripher of the figure, as from A to B, from A to C, from A to D, &c. then take the line A C, and by the 45 Chapter, Prop. 3, ſeeke a line which ſhall be to A C, as 30 to 40, which let be A F; do ſo to A D, ſo ſhall you find the line A G; do ſo to A E, and A B, ſo ſhall you finde the lines A H, and A I. Laſtly, if you take your poynt in the Area, as at A, doe as before with A A, ſo ſhall you haue A K; then draw the lines K I, or A I, I F, F G, G H and H K. If you take your poynt in the Area, I conclude either of the inſcribed figures, as A F G H K I made on the poynt A, taken in the Area, or A I F G H taken in the corner A, in like vnto the figure A B C D E, and that their ſides be in ſuch proportion as 30 to 40.



Or thus otherwiſe.

Let the numbers be 30 and 40, multiply 30 in 180, ſo haue you 5200, which deuide by 40, the quotient yéeldeth 130; then worke with 180 and 130, as you did before with 40 and 30, and all will be one: and if you can no Arithmeticke, you be taught to performe it in the ſecond Booke, or in the fift Booke by my ſcale. Let this conferred with the preſcript of the Chapter be ſufficient to teach you for to haue circumſcribed; that is, to haue made a greater, or to haue made the leſſer or greater by themſelues, according vnto the proportion aſſigned. Now I proceed according to promiſe, vnto a further diſcourſe of deuiding grounds.

Problema 10.

To deuide or cut off any number of acres from any parallelogram, be it square, Rombus, &c. by a right line drawne from a corner to the opposite side.

In this worke you be to consider two things, that is, whether the quantity you would inclose exceede the moyety of the figure, or whether the medietie of the Area of the figure exceede the quantity to be inclosed. If the portion inclusiue be lesser then the mediety of the Area, multiply the number of pearches that you would cut off in the opposite side to that line, whence your deuiding line is produced, and the product part by halfe the area; so shall the quotient shew you how many pearches you shall meate on the foresayd opposite line, from whence a hedge insuing to the angle, shall deuide the figure as was assigned.

To deuide any parallelogram as shall be assigned.

And this number is counted vpon the opposite side, beginning at the end next vnto the angle whence the hedge cometh.

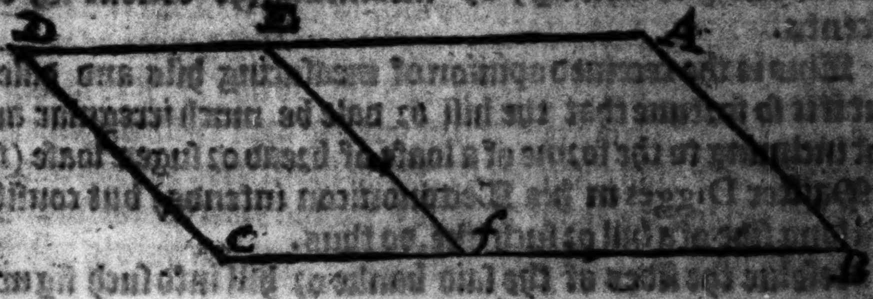
But if the portion of separation be greater then the mediety of the figure, you shall deduct it from the whole area of the parallelogram, and with the residue worke as before: onely this difference is, that the part separated is at that end of the parallelogram opposite to that which was separated before.

Problema 11.

The King granted a peece of wast ground vnto eight men, vpon condition that fiue of them shall occupy their portions together: yet to be seuered from the parts of the other three, which also occupie their three parts together. I demaund how it shall be performed.

The peece of ground granted is found to containe 16 acres, 3 day-workes, and 2 pearches, which let be A B C D: the grant-

Deuiding of grounds.



is to eight men, the proportions be 3 and 5, which make 8: by the 45 Chapter. Prop. 3, find a line which ſhall be to A D, as 3 to 5, which let be E D: drawe E F parallell to D C or A B. I conclude, A E F B is the iuſt portion that the 5 men ſhould haue, and E F C D the part that the 3 men ſhould haue.

But I ſayd before, that the peece of ground containes 16 acres, 3 dayes worke, 2 pearches, which is 2574 pearches, I would know how much each man hath vnto his part, and ſo conſequently howe much each encloſure containes. Deuide 2574 pearches by 8, ſo haue you 321 pearches, 8 cubits, and 4 inches and better: then if you multiply this number by 3, you haue the content of E C F, or by 5, of A B F E, or hauing multiplied by 3 or 5, ſubtract the quotient from 2574 the area, ſo is the remainder your deſire. I conclude by the preſcript that each man hath 321 pearches, 8 cubits, 4 inches and a little better, &c. and in the ſame order might you haue incloſed any of their parts by themſelues, and this rule is generall for any parallelogram: and if you do but conſider what is ſayd of proportions, there ſhall nothing ſeeme ſo hard but your ſkille will helpe you therein with eaſe, be the figure ordinate or inordinate.

Chap. XLVIII.

To meaſure mountaines and vallies, with a further diſcourſe of meaſuring groundes.

Mountaines and vallies.

But this worke of the hils be much irregularis not preciſe.

The order of meaſuring mountaines, and not reducing them into plains as before, is, firſt you muſt meaſure the circuit of the baſe of mountaines or compaſſe of the brim of vallies, which two adde together: then in mountaines meaſure the longeſt and ſhorteſt aſcent from the baſe vnto the toppe of the ſaid mountaine, which alſo adde together: then multiply or enter your table with halfe of the two aſcents, and halfe of the circuite of the baſe and toppe, ſo haue you your deſire: ſo of vallies onely reckoning, or meaſuring the deſcent for the aſcents.

This is the receiued opinion of meaſuring hils and dales, but if it ſo fortune that the hill or dale be much irregular and not inclining to the forme of a loafe of bread or ſuger loafe (for ſo Maiſter Digges in his Tectonicon intends) but conſiſts of a long ſide of a hill or ſuch like, do thus.

Reſolue the ſides of the ſaid banke or hill into ſuch figures that

To meaſure hils and vallies after a new way.

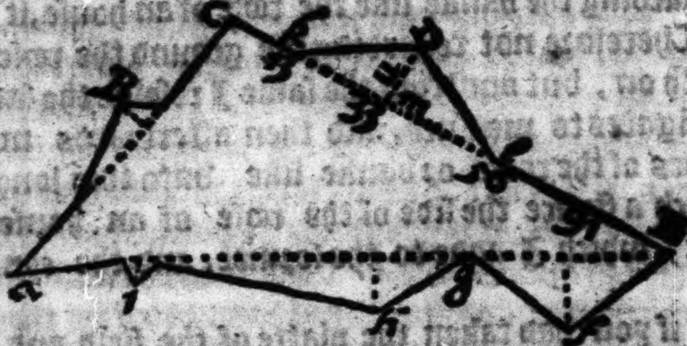
that it will moſt aptly receiue, and then meaſure the ſame according to the figure it doth repreſent; and in ſo doing you ſhall auoide errors; for if I meaſure the ſide or roofe of an houſe as it were plaine I haue the trew contents, and therefore I wil will take a plaine enſample: imagine that the roofe of an houſe, from the wall plates vpwards did ſtand in the middeſt of a plaine field, now if you did meaſure the contents of the field not regarding the banke like the roofe of an houſe, it were too litle. Therefore not regarding the ground the roofe or banke ſtandeth on, but omitting the ſame I reſolue the ſaid field into apt figures to meaſure, and then afterwards meaſure the two ſides of the roofe or banke like vnto two long ſquares (for ſuch a figure the ſide of the roofe of an houſe doth repreſent) which I adde to the former, and the contents appeares.

But if you had taken the platte of the field, and ſo caſt vp the contents without regard of the hill, then muſt you haue meaſured the hill as before, and added the contents thereof to the contents of the field; next muſt you alſo haue taken the plat of the ground that the banke did ſtand on by meaſuring about the foote of the ſaid banke, and alſo haue giuen the contents of the ſaid plat of ground that the hill did couer or ſtand vpon, which you muſt haue taken from the former totall, and then the remainder is the trew contents of the field & hill, viz. of ſo much ground that is to be ſeene, but we take no notice of ſmal bankes or vallies.

Example:

The contents of the field is 40 acres, of the banke 10 acres, of the ground that the hill ſtands vpon, 4 acres; 40 and 10 added together make 50, from which I take 4; ſo there remaines 46 acres the trew contents, whereby the contents of the field by reaſon of the hill containes 46 acres, which being plaine had ben but 40. acres,

And here I would haue you note that whereas in the 8 Chapter of the firſt part of this booke, I ſhewed you how to go round aboute the field, ſtill taking the quantity of euery ſeueral angle, here I let you to wit that if the ground be full of angles you may meaſure ſuch hedges as if it were one ſtraight line, remembring at euery ſmall angle, to meaſure how much he doth giue out, which note downe, & againſt what part of the ſtraight line the giuing out was: and this ſtraight line I would haue you to call the viſuall line, and the line of giuing out muſt be meaſured into the very vtter angle perpendicular from the viſuall line, becauſe you may the eaſier protract: and as you noted the angle of giuing out, ſo likewiſe muſt you note the point where it commeth into a right line againe, and by this meanes may you reduce any irregular péece of ground into a regular & eaſie forme of meaſuring.



Let the irregular field be, A B C D E F G H I, which by the viſuall lines A C, C E, and A E, you ſee I haue reduced into a tryangle, ſo that whereas there were fiftéene angles to be obſerued, you ſee we néede but thrée; then for the giuing out at D in the line C E, I worke thus. I take the angle A C E, and meate the viſual line C E, & in my meating I note where the giuing out begins, as at K 13 pearches: then I meate forward vntill I come againſt D, as at M 33 pearches: there the angle giueth out furtheſt: then I meate in a right line from M to D 11 pearches which I note downe (and let M D concurre with C M at right angles in M) then I procéed forwards from M in meaſuring, as to L, 56 pearches, where the giuing out commeth in againe; then I procéede in meating vnto E, ſo C E the viſual line is 91 pearches: ſo that you may ſée that the angle of deflection beganne at 13 pearches, as at L, and that the very Tropick of deflection was at M 33 pearches, containing 11 pearches as M D; and that the helical deflection came into the right line A E at 56 pearches, as at L; & ſo by taking ſuch notes as theſe be, all the reſt performed with greter eaſe and ſpéed.

Many other thinges muſt be omitted to the diſcretion of the Geodetor or meaſurer, which would ſéeme vaine and proue tedious to be aggregated in one volume: ſuch things that be not ordinary, I haue here ſet downe, and ſome ſuch as I am certaine were neuer mētioned heretofore by any. We haue diuers bookes extant for the Mathematical part of meaſuring grounds,

firſt

as firſt Maiſter Beneſe, whoſe labours might as well haue ſerued as any one of his ſucceſſors, if there had béene no more fit to ſpeake thereof; but ſuch is the acuity of our refined wits, that they obtaine a more daily affectation vnto the arte by euery of their new additions: Firſt Maiſter Beneſe, he contriued tables and taught to meaſure ground wel & plainely; than comes Maiſter Digges and wittily addeth the meaſuring of ſuperficies & ſolides, diligently calculating tables: Maiſter Lee, he addeth the legall part of Suruey. And laſtly comes I. N. and propounds a dialogue explaining thereby what he thought conuenient, and for my ſelfe, what I haue added or deuiſed, I referre to your conſideration: Amongſt many things I haue added the order of making a platte, with briefe tables to expreſſe euery ſeuerall commodity riſing or accrewing therein, and if this like you not, you may ſee another in the ending of the booke of the Geographical inſtrument.

Solas good as the beſt.

Chap. XLVIIII.

Of the making of a Table to declare euery ſeuerall tenor and commodity, riſing in any Manor, &c.

The making of a neceſſary table for a ſuruey.

IT is not ſufficient for one to take the true plat of a Manor, and to render the true contents thereof in acres &c. but you muſt alſo acquaint the Lord of the Manour what eſtate euery tenant houldeth by, that is, whether the lands they hold be free hold, or whether they haue a tearme therein for liues, yeares, at will, or ſuch like: then muſt you ſee what medow ground, what errable, what paſture, and what woodland is belonging vnto euery ſeuerall tenement, and what quantity of ſuch paſtures belonging to each ſeuerall tenement, that is, how many acres of woodland, how many of medow ground, &c. then is it requiſite to ſee what rent each tenement payeth, and what their tenement were worth, if their eſtate for life, or yeares, were expired: then ſhould you take notice, what time of their eſtate is compleat, next ſhould you ſee what ſeruices each tenant oweth vnto his Lord by force of the leaſe, or otherwiſe, then what number of ſheepe and other great cattell they be alowde to keepe vpon the common, if there be any: then ſhould you ſee what commodities riſe in the Lordſhip, and what profit may accrew vnto the Lord thereby, and in whoſe grounds, and what ground they ſtand in, to the end the Lord in his charmay the better conſider the poore tenant, for the loſſe of his ground: for it may ſo fall out that a moyne may happen in a medow of ſome one of his tenants, which happely may be all the medow ground the tenant hath: and the moyne ſtill continuing, God forbid the tenant ſhould be ſo much damnified, as to leeſe the moſt commodity thereof, ſince he ſtill payes his rent: theſe and all ſuch other things happening it is requiſit the ſurueior ſhould take notice of, and acquaint the Lord, as well of the one as the other: and for the more liuely vnderſtanding, I haue here drawne the epitome of a Lordſhip, &c. in ſuch a compendious forme as I preſume the like hath not bene publiſhed.

Vpon the one ſide, thou ſeeſt the true proportion of the Lordſhip or Manour, and euery parcell of ground therein contained, then on the other thou ſeeſt a table to expound all that we haue ſaid before, directed therein by letters alphabettically as will be plaine by an example or two.

Example.

William Aſhbe is my tenant, I would ſee what tenewre &c. he holdeth by.

On the left hand I ſee he is tenant at wil, then proceeding rightwards vntill I come vnder the title of medow, there doe I ſee that he hath but one parcell of medow ground, and that doth containe 1 acre, 2 rods, and 4 day-works of land: the letters A B telling me, that where I find thoſe two letters in the platte, there is the peece of medow, and the name of the ſaid peece, which you ſhall finde to be a cloſſe, and ſo proceed vntill you come to the end of the table.

Another Example.

William Cocke is my tenant, I deſire his tenewre eſtate, &c. on the left hand, I ſee his tenewre is for yeares, and he hath in poſſeſſion 2 parcels, of medow ground, containing 4 acres, 1 rode, 3 day-works, 1 pearch, and Æ directs me to find how they ſtand in the Manour, where I find their names and ſeuerall contents as ſmal acre containing 1 acre, 2 day-works, 1 pearche. And new medow containing 3 acres, 1 rood, 1 day-worke, 1 pearch: in like manner muſt you find wood ground, paſtures and errable, as is plaine in the table, and you muſt note in each row vnder the title of acres, that the vppermoſt figure vpon your left hand repreſents acres, and that on the right hand roods, the lower on the left hand day-works, and the

A Table to declare all the seuerall Co… Mannor of Sale, &c.

Tenewers in ſpeciall.	Tenants names.	Medo	wood	parcels.	Acres.

A Table to declare all the ſeuerall Commodities iſſuing out of the Mannor of Sale,&c.

		Medo.		wood		paſtur,		Errabl		Rents		Eſta tes			Rate.	
Tenewers in ſpeciall.	Tenants names.	parcels.	Acres.	parcels.	Acres.	parcels.	Acres.	parcels.	Acres.	now pai.	improu.	time left	time exſ.	Seruiſers.	Sheepe.	Beaſts.
At will.	Willi. Aſhbe.	AB 1	1 2 4			AD 1	2 3 0 0	AC 1	1 1 5 0	s 9	l 3	—	—	△	40	3
At will.	Robert Poine															
Ter. of ye.	Will. Cocke.	AE 2	4 1 3 1	AF 1	4 1 0 0	AG 3	10 0 8 0	AH 2	7 0 8 6	s 10	1 6	21	8	*	50	2
Ter. of ye.	Dauid welch															
For yeares	Charles Mac.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
For life.	Ric. Rumley.	AR 3	10 3 8 0	AP 1	4 1 5 1	FF 2	11 0 4 0	PP 1	5 1 8 3	s 15	l 11	3	1	R	30	3
For life.	Rowl. Dod.	LL 2	14 1 6 3	H 1	1 3 6 2	HH 1	3 0 6 0	II 1	3 3 5	s 15	1 8	3	2	P	30	2
For life.	Ra. Adames.											—	—	—	—	—
Socage.	Rich. Preene.	XX 2	6 0 1 1	D 1	2 0 2 2	B 1	3 2 1 2	E 1	4 2 7 2	s 18	1 9	—	—	L	50	1
K. Seruiſe	Georg Hock	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Durgage.	Robe. Royde		—	—	—	—	—	—	—	—	—	—	—	—	—	—
For life.	Ioh. Driuer.	BB 2	l 3 3 0	—	—	—	—	—	—	1 2	1 20	3	2	△	—	2
For years.	Rich. Houte.	S 2	6 1 3 0							3	1 14	21	14	*		3

Seruiſes proper vnto each tenant in the Manor, and where Heriots be due,&c.

To grinde at the Mill.	△ R. P.	Two dayes with his Teeme in ſeedneſſe	△ * P.
To reape in the Harueſt	△ R. P.		
Two daies with his Teeme in Harueſt to carry corne.	△ * P.	To appeare at his Courts one day with his Teeme in Lent ſeedneſſe.	△ * R. P. L. * R. P.
His beſt beaſt at his death.	△ *	Money at his death for A Heriot.	R xx. ſhillings. P. x. ſhillings.

Commodities riſing in the Manor.

19. Acres of common paſture.

16. Acres of common Woodes, wherein be 600. great Limer Trees, 100. Aſhes, &c.

	Worth by yeare.	The tenewer,	Parcel.
One quarey of Sclate.	Twenty Markes.	Wil. Aſhbee.	AB. Long medow.
One quarey of Free-ſtone.	Ten pound.	Wil. Cocke,	AF. Birches.
A Moyne of Lead.	An hundred pound.	Ri: Rumley.	FF. Blacke field.
A Moyne of Iron ſtone.	Fifty pound.	Ro. Dod.	HH: The ſleade.
A Moyne of Cole.	4. hundred pound.	Ri. Preene.	D.

The Manor is charged.

With one { ANnuity of twenty pound for 18 yeares,
Rent charge of one hundred pound.

Note the Demeſnes with the ſite of the Manor houſe, &c. being faire and in good reparations conteines 500. acres, 220 of errable, of paſture 150, of medow 130, left vnplatted.

Alſo the Tenants claime paughnage for foure pence a ſwine in the common wood.

Place this Table and Map betweene the folioes 254. and 255.

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16 JY 1902

that the vppermoſt figure vpon your left hand repreſents acres, and that on the right hand roods, the lower on the left hand day-works, and the other pearches.

But to procéede to the eſtate, I find that William Cocke was tenant for yeares, then if you procéed in a right line rightwards untill you come under the title of eſtates, there ſhall you finde that his eſtate was for twenty one yeares, ſtanding under time leaſed: next in the row under time expired, there ſhall you find eight yeares, and ſo much of his twenty one yeares were expired, at the time of taking the ſurueye. In the next row, under ſuruiſes there ſhall you finde this marke * which refers you to the little table of ſuruiſes, below the other great table: and ſo often as you find that ſtarre there, ſo many ſuruices is the ſaid Willam Cocke bound to doe to his Lord, which you ſhall find to be foure times, and thoſe foure ſuruiſes be.

Firſt, 2 daies in the harueſt to carry corne, 2. to be two daies with his téeme in ſéedneſſe. 3. one day with his téeme in Lente ſéedneſſe. 4. his beſt beaſt at his death.

Laſtly under the title of Rated for, you ſhall find how many ſhéep, and great beaſts he is allowed to put into the common, where you ſhall find that the foreſaid William Cocke is rated at 50 ſhéeps, and 2 beaſtes, as appeares under the ſeuerall titles.

Then what other commodities riſe in the Manour, & what the ſaid Manour is charged with, you may plainely perceiue in the tables underplaced of purpoſe.

As there is a moyne of iron ſtone worth 50 pound by yeare, it is in the ground of Robert Dodde, and then the letter (HH) refers me to the upper great table, which ſheweth me that the ſaid moyne lieth in his paſture ground, which is called the Slead, containing 3 acres, &c. and if you would ſée where ẏ ſaid péece of ground ſtandeth in the Lordſhip, the letters (HH) will direct you.

And here note that if you haue occaſion to hedge or ditch a parcel in the manor, you may meat the ſame with your paire of compaſſe and ſcale in the foote of the platte as trewly as if you did goe into the field, and ſo may you know what the doing thereof is worth &c. and ſo ſet hedgers &c. far worke.

Chap. L.

Certaine Apopthegmes requiſite for all Geodetors or meaſurers of ground to vnderſtand.

Geodeticall Apopthegemes.

ALL grounds be either naturally good of themſelues, and ſuch be knowne by the herbes, &c. as they yeeld; or artificially good, and thoſe are made by endeuors and painefull trauels in manuell labours.

Grounds naturally good, bring forth

Wall worts	Blacke thornes.
Soft ruſhes.	Black berrie trees
Mallowes.	Corne thiſtles & great thiſtles.
Three leafed graſſe.	White or red honiſucles.
Straight and faire trees.	Hony ſuckle leaues.
Broad elmes.	Graſſe thicke at the ground.
Great Okes and Aſh.	Good wild fruits.
Slo, or Bullace trees.	Good wild hearbes.
Wilding, called crab-trees.	Or any one of all the foreſaid.

Artificiall good grounds, are

Made by continuall heaping of dung thereupon, ſuch are about London.

Where old Caſtles or buildings haue bene ſituate.

Where pooles haue heretofore bene, by carrying the mudde forth, but then it is beſt to let it ly vpon heapes till it be dry, and after carry the ſame vpon the land and ſpread it.

Or where land flouds & waters be brought ouer the ground.

Made by letting the graſſe grow 6 or 7 yeares vneaten.

Where many ſheepe are folded, which they vſe in ſome countries, and ſo ſaue dunging their arable grounds, by burning the ground:

But grounds would be conſidered according to the nature thereof, viz. hot or cold, apply to
- hot: mudde.
- cold, dung, &c.
- cold: limeſtone.
- marle, &c.

Signes of fertill grounds, and ſuch as be rich, are

Where Crowes and Pies follow the plough.

Mellow and fat grounds that will ſoone be diſſolued
Such which be fat and ſtiffe
Where fearne doth grow.
} beſt for corne.

The colour of the earth being like new wax.

The ſwelling of the earth, and looking blacke and dirty after raine.

A blacke or yellowiſh earth, which keepeth not raine water but drinketh it vp.

Where the face of the earth is not hard in winter.

Where the earth doth yeeld a pleaſant ſauor after ſunne ſet.

Where after a ſhower of raine following a great drought, you find pleaſing ſmels.

If a péece thereof haue a good taſte after it hath line foure houres in pure water.

Which being wet ſeemeth clammy, and cleaueth vnto your fingers like dough.

If a digged pit lie open thrée or foure dayes, and the mould earth taken thence being caſt in againe, afterwards ſwell or riſe aboue the brimme of the pit being troden downe.

Signes of barren, leane and vnfruitfull ground.

If it riſe but to the brimme of the pit, indifferent ground.

If it ſhrinke in vnder the brimmes of the pit, or gape or chawne, barren ground.

Where the earth wet with raine doth harden & ſhew white.

Which be white and bare.

Which abound with grauell, ſand or chalke, taking mixture of earth.

Which in a temperate ſommer doth gape and open.

Which aboundeth with great grauell, ſtony or glittering duſt.

Which abound with grauell or peble ſtone.

Which is ſo dry that it burneth the rootes of plants put therein.

Which is heated and gapeth with ſmall heate of the ſunne beames.

Signes of bad ground, are.

A rough, ſtiffer or tough, a fenniſh, mariſh or ſlime, a red dry and thicke, a leane and cold, a dry leane and ſtiffe ground.

Where the face of the earth is hard in winter.

Bad grounds naturally yeeld

Short trées or ſcrubs.

Alder trées, hard and pricking plants, ill reliſhing herbes, bitter, Iuniper, thornes, briers, fyrſes, heath, wormewood, lothſome and ill weedes, withered fearne and plants, arguing a cold ſoyle, ill coloured herbes, weedes and plants, arguing a wet ground ouer abounding with moiſture.

The yearely growth of trees is knowne

In ſome by the knots and ioints, in ſome by their branches; but the generall way for all is, giue a ſlope ſtreake in the rind of the trée, ſo that it pearce vnto the body, then ſée in the rind ſo cut, how many ſeames or ſcores be therein contained betwixt the body of the trée and the vtter ſide of the barke, and ſo many yeares growth is the ſaid trée.

Likewiſe may you perceiue the ſame if a trée be fallen, by the ſeames that be within the body of the trée running about the hearte, like a number of parallel circles about one center, for ſo many ſeames or circles, ſo many yeares growth is the trée.

The aire according as it is ſituate breedeth pure and wholſome bloud, or corrupt and bad humors in the body of man, and ſo chargeth or infecteth the heart, the which is the moſt noble part.

A ſound and pure aire is

Made hote ſoone after ſunne riſing.

Made colde ſoone after ſunne ſetting.

Which yéeldeth a pleaſant ſmell after raine.

Cléere and not euaporated, open and lightſome.

Where the North wind bloweth, for it clenſeth the aire, but cauſeth dry colds, and hurteth plants.

Where the Eaſt winde bloweth in the morning.

A corrupt and infectious aire, is

Made by influence of diuers ſtarres.

Made by the vſuall blowing of the South-eaſt and by South-wind, which gendreth clouds and ſickeneſſes, or by the South-wind or weſt in the euening.

Where the ſunne is long a making warme after ſunne riſing.

Where the aire is long hote after ſunne ſet.

Where the aire is cloſe, cloudy or thicke.

Where aboundance of carrion lieth long aboue ground.

Where waters filthy and defiled with watering hempe, throwing of carrion, emptying of vaults &c, ſtand long.

Where multitudes of vncleanly people lie in ſmall roome, many ill fauoring trades in narrow lanes wanting aire, with vnclenſed cellars and ſuch ground roomes, abounding too much in London.

Waters are often led by pipes and gutters vnto houſes, and the fineſt leading of them in deſcending grounds, is in trenches, fild full of pebbell ſtones, and couered ouer with earth: and you muſt note that as there be corrupt and vnwholſome aires, ſo be there bad and naughty waters vnfit for the vſe of man

That water is beſt and pureſt for mans vſe which,

Runneth Northwards.

Runneth out of a hill into the Eaſt, from the North, and is the beſt that runneth fartheſt in courſe.

Runneth ſwiftly through ſtones, rockes, &c. and from a hill.

Hath no ſauor, ſmel or colour, but is thinne and pure.

Will take the colour of any thing caſt therein.

Will be ſoone hot and cold.

Is warme in winter and cold in ſommer.

Yeeldeth no ſtaine after a drop or two, is let dry vpon a poliſhed ſteele glaſſe, plate of ſiluer, braſſe, which boyling yeeldeth leaſt filth to be ſcummed off, or being poured out leaueth the veſſels bottome cleaneſt.

Is lighteſt in waite.

Is taken in ſommer after a clap of thunder, or after a mild ſhewer, but not ſuch as falleth off houſes and out of gutters.

The bad and vnholſome waters be ſuch, which are oppoſite vnto the former, as ſuch which runs into the South, which be heauy, ill-ſauored, and ſtaine what they fall vpon, which run ſlow, which is long in heating.

Chap. LI.

Of ſurueying of ground, of making a new kind of particular of apportionating lands, of ancient meaſure, and buying annuities.

Surueying of grounds conſiſts of two parts, Mathematical and legal, the Mathematicall is performed inſtrumentally, as in the firſt parte of this booke, the inſtrumentall operation is either to deliuer the true contents of euery particular, by plot or ingroſement; to ingroſe the contents of any Manour is to meaſure euery particular truly and preciſely, and to write the ſame in Latine orderly, in a faire booke with broad margent notes, eaſily and quickely offering the contents to the eye, and this is performed after diuers waies, ſome beginne with the ſide of the manor place, then proceed to the common fields, &c. butting and bounding euery ſeuerall particular, which is not materiall, vnleſſe there be free holders in the manor, or one man holding free hold, and coppy, or leaſe land both. Others begin with the circuit, then go to the ſight, next to the Auouſonage, and then to the tenants.

But the beſt way, in my fantaſie, is firſt hauing giuen the title to beginne with the Manor houſe, noting the buildings, &c. then to procéede to the demeſnes, then to the Rectory, next to the freeholders, next to the Tenants for yeares, liues, will, &c. noting downe euery ſeuerall particular by name, with the true quantity of acres, and what an acre is worth: For you muſt note that ſome acres be better then ſome, according to the place it lieth in. For medow grounds in ſome vpland grounds may be worth but iiij s. the acre, in ſome places worth v. s, in ſome x. s. in ſome xx. s. or xxx. s. or xl. s. yea in ſome I know medowes let for iij. l. the acre, and yet the Tenants haue a good bargaine. Now all this being noted, draw a right line to containe euery particular belonging to that tenement, as in the end of the Topographicall Glaſſe.

Writing in the right margent in the middeſt of the ſayd right line the yearely rent, and at the lower ende the improuement: And laſt by collect, how many acres of medow, how many of paſture, &c. each tenement hath belonging thereunto, and then ſay, *In pratis* 40 *acr. in paſturis* 80 *ac. &c.* according as you may gather by this one tenement vnder written, in manner and forme aforeſayd.

Ancient mea-
ſures of grounds.
Hide of land.
Plough land.

A Cantred.

A Barony.

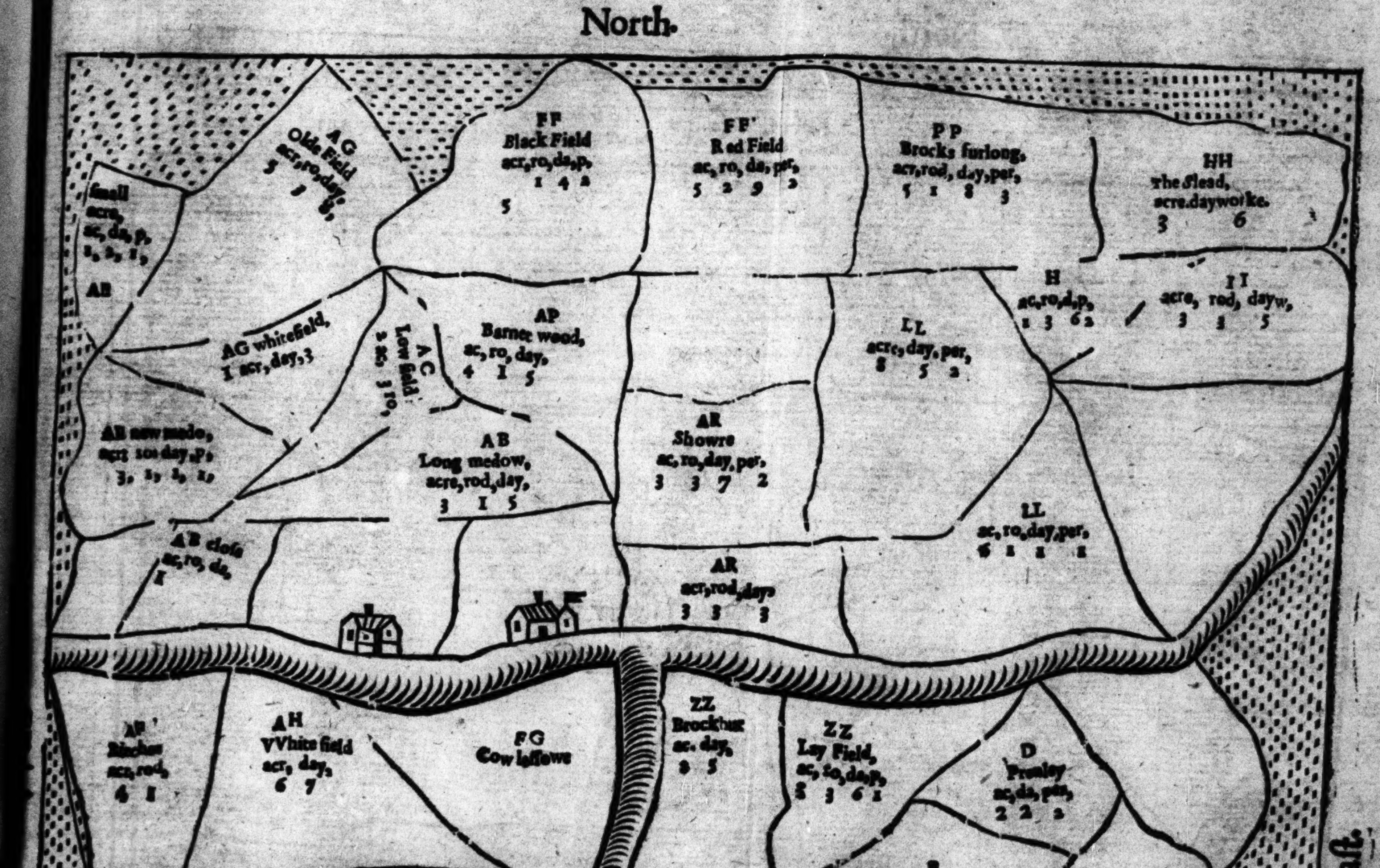
A Earldome.

To apportion
lands.

To purchaſe
Annuities.

for every acre according to the preſent rent : therefore where the rent of every ſeverall particular is not knowne, the ſur-

Superuiſ. maner. de Sale ibidem capt. per ambulationem examinationem & menſurationem tam, A. H. general, ſuperuiſor. quod T-N. Domini maner. prædict. & per mandat. eiuſdem, quam per ſacrament. R.B, &c. tunc ibid exiſtent. 12. die Octobris, anno Domini 1606, annoque regni Iacobi, Dei gratia, Angliæ Franciæ, & Scotiæ.


North.
AG
Olde Field
acr, ro, day,
3 1 8
FF
Black Field
acr, ro, da, p,
1 4 2
5
FF'
Red Field
ac, ro, da, per,
5 2 9 2
PP
Brocks furlong,
acr, rod, day, per,
5 1 8 3
HH
The ſlead,
acre. dayworke.
3 6
ſmall
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AG whitefield,
1 acr, day, 3
AC
Low field
2 ac, 3 ro,
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Barnet wood,
ac, ro, day,
4 1 5
LL
acre, day, per,
8 5 2
H
ac, ro, d, p,
1 3 6 2
II
acre, rod, dayw,
3 1 5
AB new medo,
acr, ro, day, p,
3, 1, 2, 2,
AB
Long medow,
acre, rod, day,
3 1 5
AR
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ac, ro, day, per,
3 3 7 2
LL
ac, ro, day, per,
6 1 1 1
AB close
ac, ro, da,
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AR
acr, rod, day,
3 3 3
AP
Birches
acr, rod,
4 1
AH
VVhite field
acr, day,
6 7
FG
Cow leſſowe
ZZ
Brockhus
ac. day,
8 5
ZZ
Lay Field,
ac, ro, da, p,
8 3 6 1
D
Pronley
ac, da, per,
2 2 2
B
Chapell Field
ac, 3, ro, 2, d 1, p, 2,
Z
Cow croft
ac, ro, d, p,
4 2 7 2
The Lee,
acr, da, per,
2 2 6
AH
East.
Common
ac. rood
19 2
BB
Mill
ac, da, pe,
2 5 2
S
a, r, d, p.
2 1 3 2
S
ac, ro, da, pe,
3 3 9 2
South.
10 20 3
Scala Perdicarum.

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Iohannes at Noke tenet per Indenturam gerent. dat. 28 Septembris, Anno regni domini Regis, &c. vnum meſuag. ſiue tenementum cum certis terris, viz.

Domum manſual. iacent. inter regiam viam ibidem ex parte occidental. & oriental. inter tenementum A. D. *& communem campum ex parte boreal. & le broad ſtreete ex parte Auſtral. & continet 28 perticum in latitudine & 62 perticum in longitudine, & meſuagium ſiue tenementum predictum ſufficienter conſtructum ac etiam tegulatum cum vna aula, vnum canaculum vocat. a parlor, octo cameris & coquina cum vno ſtabul. & vno horreo, ac le oxhouſe, ibid. cum ſtramine coopertum continen.* 8 bayes, *ac ceteris domib. neceſſariis adiacent.*

	l.	s.	d.
	31.	7.	6.

Vnum clauſſ. prati vocat. le broade medow, cont. 20 ac. qualibet acra valens 30. s. — 30. l.

Clauſſ. paſtur. vocat. le healde, cont. 10 acr. qualibet acr. 15 s. & reddit per ann. 7. s. 6. d. — 7 l. 10 s.

Clauſſ. terr. arabil. vocat. le mil field, cont. 20 ac. qualibet acr. valens 8 s & reddit per annum 1 s 6 d — 8 l. 0 s.

Clauſſ. prati vocat. long medow, cont. 2 acr. qualibet acr. 18 s. & reddit per ann. 13 s. 6 d. — 1 l. 16 s.

And ſo of all the reſt, as you finde it: then ſay,

Valet dimittendum. 47 l. 6 s.

Laſtly ſay according to the true improuement.

		Acres.	l.	s.	d.
Iohannes at Noke tenet in	*pratis*	22.	56	0	0
	paſturis	10.	7	10	0
	terr. arabil.	20.	8	0	0

But ſeldome times you ſhal come to a Manor, and finde all the particulars valued by themſelues, as before, vnleſſe in ſome certaine places by an ancient reſeruation: for commonly the tenement is taken altogether, giuing a fine and ſome ſmall rent, ſo that it is hard to come to know what they pay for euery acre according to the preſent rent: therefore where the rent of euery ſeuerall particular is not knowne, the ſur-

To apportion lands.

ueyor muſt apportion the value and worth of the acres, according to his diſcretion. For medows lying barren and high, or low and fenny, yeelding greene hard ruſhes, flagges and knotty graſſe, are not worth aboue 4 s, 6 d *per annum*: but whether the rent be knowne of euery particular or not, the receiued order of apportionating is thus. Get the value of an acre of arable land (but aime not at the beſt nor the worſt, as hereafter) then double the value of the arable land, and to the product adde halfe the value of the ſayd acre of arable, ſo haue you the worth of an acre of paſture: then multiply the value of the arable acre by 4, and to the product adde halfe the worth of the ſayd arable acre, ſo haue you the value of an acre of medow. And note, if the medow & paſture conſiſt moſt of a fertill ſoile, take the value of your arable acre in the beſt place, &c. But this rule is not certaine, and therefore muſt be amended according as the goodneſſe of the ground ſhall apeare: neither be woods, orchards or gardens ſubiect vnto this apportion.

Ancient meaſures of groũds
Hide of land.
Plough land.

In the ſecond Booke and ſecond Chapter I recited a meaſure ſet downe by Fabian, but that is not certaine in all places: For there I told you, that 8 hides make a knights fee, but in the Duchy of Lancaſter they count but halfe ſo much, to wit, 4 hides, euery hide 4 plough land, which is ſo much as one teame may till in a yeare.

And this plough land is called in the North an Oxgange, euery plough land is 4 yard land, euery yard land 30 acres, ſo that euery plough land containes 120 acres, euery hide 480 acres, and euery knights fee 1920 acres: but ſome account it more, as euery knights fee 5 hides, euery hide foure yard land, euery yard land 24 acres, but in the ſecond booke euery knights fee is 8 hides, &c.

A Cantred.
A Barony.
A Earledome.

Now two knights fee make a Cantred, which according to the firſt of the former accounts is 3840 acres; 6 Cantreds & $\frac{11}{16}$ make a Barony, which is 25600 acres, whoſe releiſe is 100 markes; one Barony and a halfe makes an Earledome, which is 38400 acres, whoſe releeſe is 100 pounds: but I meane not that euery Earledome or Barony of neceſſity muſt haue ſo much and no more: onely theſe were the proportions at the firſt inſtitution.

Annuities.

To purchaſe Annuities.

And if any annuities be iſſuing forth of the Manor which you be deſirous to purchaſe, by my tables publiſhed in my Almanacke 1608, ſéeke what 10 li. *per annum* is worth for the time propoſed, & then making that your radix by the rule of proportion taught often before, obtaine your deſire, ſaying, if 10 li. *per annum* be worth ſo much for ſo many yeares, what is 60 li. &c. worth? Concerning my Almanacke for this yeare 1610, there was in my abſence a moſt rare kind of Tables for the computation of time omitted for the priuate gaine, and at the eſpeciall requeſt (as I heare) of ſome priuate man: whereby I was much iniuried, my booke quite defaced; and the common weale reſtrained from the generall benefit thereof, as though they or we were tied to a particular method: but if it might haue bene a hinderer to any, more then the ſame might haue benefited many, I then reſt well contented.

My Almanacke

CHAP. LII.

To reduce Statute meaſure into cuſtomary meaſure, or any kind of meaſure vſed in any particular place: or contrary.

IN the ſecond booke of our Geodeticall Staffe, I gaue, certaine notes concerning the diuerſitie of meaſures vſed in diuerſe places, and in my Art of Geodetia I omitted to deliuer any propoſition that might yéeld the proportion of one to the other: For indéede as the Chapters are there ſet downe diſorderly without any commendable conſequence, ſo was my leyſure but ſhort for the accompliſhment of the ſame, neither could I intend to alter the firſt manuſcript, but did onely procéede, adding (though not in their proper places) ſuch things I ſaw wanting, but tooke them by whole ſale, one with another: for my intent indéede was not to publiſh the ſame.

To reduce ſtatute meaſure to woodland meaſure.

But to procéede, when you know the contents of any péece of ground according to Statute meaſure, and are to deliuer the contents thereof according to 18 féete in the pearch or pole, commonly called woodland meaſure, do thus.

You are firſt to conſider the loweſt proportionall termes of their lines: for the like proportion that the ſquare of the one terme beareth to the ſquare of the other, the like ſhall the acre of the one beare to the acre of the other, or the ſquare pearch of the one to the ſquare pearch of the other.

The loweſt proportionall termes of $16\frac{1}{2}$ is 11, and of 18, 12, (which you muſt find by the abbreuiating of thē by $1\frac{1}{2}$;) now the ſquare of 11 is 121. and the ſquare of 12 is 144) by the thirteenth Chapter of the ſixt booke.

So then the proportions ſtand thus, as 121 the ſquare of 11, is to 144 the ſquare of 12, ſo is an acre of 16½ in the pearch to an acre of 18 foote in the pearch.

Therefore for the reducing of Statute meaſure into woodland meaſure, as before, multiply the giuen number by 121, and the product deuide by 144, the quotient ſhall yeelde you the contents according to woodland meaſure.

To reduce woodland meaſure to ſtatute meaſure.

But it may be that the woodland meaſure of 18 foote in the pole, will be giuen, and you required to reduce it into Statute meaſure, which performe thus. Multiply the giuen number by 144, and make partition of the product by 121, ſo haue you your deſire.

And here note, that if ẏ giuen number be expreſſed in acres, reduce the ſame into pearches for your more eaſe in working.

CHAP. LIII.

Of the platting or caſting vp of one Manour, &c. by diuerſe ſcales, as Statute meaſure, and woodland meaſure, &c.

I Haue ſeene it ſo fall out in platting of Manors, Lordſhips, &c. that there hath bene woodgrounds therein to be meaſured, not according to ſtatute meaſure as the former was, but after 18 foote in the pearch, which you may do thus. Meaſure it by one ſcale, as you did the reſt, then afterwards reduce it by the laſt Chapter. But ſay that ſome ſtubborne people not ſeene in the art of our reducement, will onely haue it meaſured in the field, according vnto 18 foote in the pearch, and not ſuffer vs about the woods to vſe the Statute meaſure: wherefore I ſhall be driuen to worke by another Scale, otherwiſe I ſhould thruſt the plat out of proportion.

To meaſure grounds by two ſcales.

Therefore I muſt worke thus: take 12 of thoſe parts of the ſcale I formerly platted the reſt with, and that length deuide into 11 equall parts, ſo haue you made a new ſcale, which you may make as lōg as you wil, according to thoſe 11 equal parts.

Now may you ſafely meaſure according vnto 18 foote in the pearch, ſtill platting or laying the meaſured lines downe by this new ſcale, in ſo much ẏ though you meaſured the Manour by a ſcale of 16½ foote in the pearch, and the woods by 18 foote in the pearch, yet protracting by this new ſcale, all the grounds will abut and bound in due and true proportion, euen as they

To meaſure and plat woodgrounds by 18 foote pole, ſo that it ſhall agree with the reſt of the plat taken by ſtatute meaſure.

had bene measured by one ſcale of 16½ foot in the pearch.

For theſe cauſes it were not amiſſe to haue two ſcales made according to the preſcript.

And take this note, that all grounds meaſured by a Statute pearch, and platted by a ſcale of 12 in an inch, that you may readily find the contents according to 18 foote in a pearch, if you doe but caſt vp the platte by a ſcale according to 11 parts in an inch: the reaſon is becauſe 11 pearches in length of this woodland meaſure make 12 in length of ſtatute meaſure, hereby may you render the contents of any wood ground according to either.

Chap. LIIII.

In the ſuruaying of a Manour, how to ioyne all the parcels in one platte as they lye in the whole Manour.

To ioyne al the parcels in a Manour in one plat or card.

WOrking by the plaine table, Theodelitus, Geodetical ſtaffe, or any other inſtrument, the beſt rule I can preſcribe you is, firſt to get the perfect & direct perimeter of the Lordſhip, and that to lay downe by a large ſcale vpon faire ſheets of paper glued together, then goe into euery ſeuerall field in the Manour taking the true platte as you be inſtructed in the firſt part of Geodetia: and then at euery night carefully to place thoſe parcels, within the former perimeter in their proper places, which to doe you muſt take notice how one lyeth by another, that you miſplace not any: hauing finiſhed, if the particulars iuſt fill vp the perimeter, you haue truly wrought.

To change the paper in the plaine table.

But this note, if you platte by the plaine table, take as many particulars vpon one ſheet as you may, and when you change your ſheete, worke as you be taught in my Topographical glaſſe, or by helpe of your needle at euery changing of your ſheete, ſtrike a Meridian ouer the new ſheete, for your better directing your ſelfe in ioyning your ſheetes, becauſe the Meridians muſt lie parallel when you ioyne the ſaid ſheetes.

Alſo haue a care in making a platte to place the houſes, buildings, trees, and euery notable thing in your platte.

Chap.

Chap. LV.

To alter the whole platte of a Manour, and euery particular therein, eaſily and ſpeedily.

To alter the platte of a Manour to any proportion.

WHereas in the laſt chapter I inſtructed you to lay the perimeter of a Manour downe by a large ſcale for your more direct working, yet happely you ſhall be required to deliuer the ſame in a farre more leſſe proportion, and tho I haue already ſet downe diuers rules in my arte of Geodetia for the performance thereof inſtrumentally, yet ſhall it be nothing amiſſe to ſhew you an other eaſy way, for that your inſtrument is not alwaies at hand. By the inſuing Chapter, get the true plat in a faire ſheete of paper in ſuch lines that may be rubbed forth againe, then to alter the plat to any other proportion doe thus. Prepare a rule with a center hole, deuide this rule into as many ſmall equall parts as you can, & number the ſame by 10: let the rule be of ſome thinne plate.

Now to worke herewith, about the middeſt of the platte with a ſmall needle through the center hole of the rule, there faſten the ſaid rule to the paper, and the boord that the paper lyeth on: then remoue the edge of the rule to any corner in any fielde, and note the equall parts cut, and of thoſe take what part you pleaſe according to the proportion aſſigned as the ½ ⅓ or any other: your rule ſtill reſting at that angle, by the edge of the ſaid rule make a pricke according to the proportion taken, as if the parts cut be 60, & you meane to make the plat but halfe ſo big that is, then muſt you make a pricke at 30, which is halfe 60: then turne the rule to the next angle in the ſaid field, and doe the like to the proportional part of that number cut, and ſo laying the rule by euery angle make pricks at the proportionall part, and then draw a line from pricke to pricke; ſo is a figure made leſſe and proportionall to the greater, this done rub out with crummes of bread the blacke leaded lines of the field, and then proceed to the next, doing ſo to euery field ſeuerally untill you haue finiſhed, ſtill rubbing forth the blacke leaded lines as you finiſh the ſaid field.

To alter plats from leſſer to greater.

And there you ſhal note, that as you may by this doctrine alter a great platte to a leſſe, ſo may you doe the contrary, alter a leſſer to a greater, onely noting

In altering of plats from the	Leſſer to the greater,	You muſt begin at the	Perimeter of the platte.
	Greater to the leſſer,		Middeſt of the platte.

But in this you muſt not alter the center of your inner from the midſt of the platte, howſoeuer you alter the platte either from greater to leſſe or leſſe to greater: certainely this kind of worke is moſt precise and excellent for the altering plattes of Manours, ſea-cards or ſuch like, tho they vſe to performe it by croſſe lines, or ſquares, which may ſerue for that purpoſe, but not ſo well for this: others vſe to alter them by circles other waies; but take this tho ſomething Mechanicall, yet moſt requiſite, for many concluſions ſtand firme and true in demonſtrations Geometricall, though otherwiſe in practiſe tedious and vnneceſſary.

Chap. LVI.

To take a platte out of one peece of paper, and place the ſame truely in an other peece according to the ſame proportion and faſhion it had before, and that diuers waies.

To take any platte out of one papar and place it in en other.

You muſt take the paper whereupon the platte is drawne, and rub the backe ſide with blacke lead all ouer, then lay a faire ſheete of paper (or two or three glued together if the plat be large) vpon a plaine boord, and vpon that lay the leaded ſide of the platte or other ſheete: faſten them both vpon the boord at the 4 corners, then take a ſharpe pointed bodkin, and with ſomewhat a heauy hand trace all the lines within the ſaid platte, & all ſuch other things that you would expreſſe: laſtly take away the vppermoſt paper, ſo will all the lines that you haue traced, remaine vpon the lower ſheete, which you may rub out with crummes of bread.

Otherwiſe:

Lay the plat it ſelfe vpon the Table, then prepare a paper well oyled with Linſéede oyle, and faſten the ſame vpon the plat that lieth vpon the table: ſo ſhall you ſée all the lines and other notes in the plat through this oyled paper, as through a cléere glaſſe; then with a pen & inke, or a bodkin draw or trace all the lines required: ſo haue you taken the plat out of the lower paper into the oyled paper, which you may pricke and pounce, and ſo place vpon any other paper at your pleaſure: by ſuch oyled paper may any ſimple body take any worke, flower, or ſuch like, forth of any place as he pleaſeth.

Otherwiſe.

You may pricke all the lines with a ſmall néedle, as the order is, and ſo accordingly with pund coles in a cloute pounce the ſame, and then draw the lines with a pen, or penſell made of blacke lead, or a Sally cole, according as you would haue the lines to remaine, or upon any occaſion blotted out. Many formes more art-like I could deliuer, but for the cauſes before remembred theſe ſhall ſuffice.

CHAP. LVII.

To garniſh your plat.

To garniſh a plate.

YOur plat being finiſhed, and all things orderly contriued, it reſteth then for you to garniſh and beautifie the ſame with ſuch water colours as is conuenient, adding thereunto the due proportion of all houſes, buildings, &c. and for your better inſtruction lay all arable lands in red, all paſture in a ruſſet, or ſome ſuch kind of colour, and all medows in greene, decking all woodlands with trees, and doe not omit the port wayes or any other way worthy of note, nor any brooke, well, croſſe, or tree of note, or other ſpeciall marke of note: for all ſuch are true ornaments & moſt requiſite to be placed in your Card: for it is abſurd to follow many rude painted obſeruations, making trees where none be, laying greene where no medow is, and ſuch like; & take care that you make not your port wayes, brookes, &c. broader then the proportion alloweth. I haue ſeene diuerſe draw a brooke, being not paſſing one pearch broad indeed, more then 5 pearches broad, being applied to their ſcale, which was abſurd: and many more ſuch groſſe errors concerning the rules of proportion, which I omit. And ſo for this time I end this Art of Geodetia, deſiring my ability were ſuch to anſwer to the fulneſſe of thy expectation in this volume: hereafter it may be I ſhall be occaſioned to ſpeake more.

In my Topographicall glaſſe.

The end of the ſixt Booke.

Deus hæc otia fecit.

THE

THE SEVENTH BOOKE OF THE GEODETICAL STAFFE, called Trigonometria:

Containing Longimetria and Altimetria, performed by Synnicall ſuppucation, with a Canon for the dimenſion of tryangles: compendiouſly calculated for *the performance thereof.*

CHAP. I.

Geometricall definitions, propoſitions and conſequences of lines, angles, and tryangles, &c.

TRigonometria is a doctrine treating of the dimenſion of tryangles, of which there be two kinds, right lined and ſphericall; we onely at this time ſpeaking of right lined angles. Trygonometria

2 A poynt is a ſigne in a magnitude vndiuiſible. Ra.l.1.p.6. A point.

3 A line is a magnitude onely long. Rad.2.p.2. Or a line is the ſhorteſt extenſion betweene two points, or a line is the motion of a point. A right line.

4 A touch is made in a poynt, Eucl.l.13.p.3.

5 A crooked line is a Circumference, or Helix. Ra.l.2.p.7. Crooked lines.

6 A Circumference is that which is equally diſtant from the middeſt of the ſpace contained in it. ibid.p.8.

7 A Circumference is therefore made by the running of a line equi-diſtant about the center, the one end reſting fixed; or a Circumference is made by the motion of a poynt equally about the Center.

8 An Helix is that which is vnequally diſtant from the middeſt of the ſpace that is contained within: but we need not this Prop.

9 Parallel lines are ſuch that be equally diſtant one from the other euery where. Eu.35.p.11. Therefore parallel lines Parallels.

being extended infinitly neuer interſect.

10 If one line be parallell to many, all thoſe lye parallell one to another, or amongſt themſelues.

11 An angle is a liniate conſiſting in the common ſection of the Termes. Ra.l.3.p.3. or an angle is made by the concourſe of two lines.

12 The féete of the angle are the termes comprehending the angles. Ra.ibid.p.4.

13 Angles homogeneall, are angles alike in all reſpects.

14 If angles haue equall féete, they be alſo equall. R.l.4.p.5.

15 An angle is either right or oblique.

16 A right angle is made by a perpendicular falling vpon the baſe, or which doth containe the fourth part of a circle.

17 In right angled tryangles the line ſubtending the right angle is called the hypothenuſall, either of the other termes containing the right angle, may be called the perpendicular, or the baſe.

18 An oblique angle is either obtuſe or acute.

19 An obtuſe angle is an oblique angle greater then a right angle. Eu.l.1.def.11.

20 An acute angle is an oblique angle, leſſe then a right angle. Eu.ibid.Def.12.

Figures.

Of a figure.

21 A figure is a lineate magnitude, limited on euery ſide. Ra.l.4.p.1.

22 A center is the middle poynt in a figure.

23 A perimeter is that which dothincloſe a figure.

24 A radius is a right line extended from the Center to the perimeter.

25 A diameter is a right line inſcribed in a figure, and drawne through the center. Therefore

1 In one figure there may be infinite diameters.

2 The center is alwaies in the diameter.

3 If there be many diameters the center is in the concourſe thereof.

4 If two diameters interſect, the center is in ye interſection.

26 If a right line fall vpon a right line, the angles there made are equall vnto two right angles, and contrary. Euc.l.1.p.14.13.

27 If two lines croſſe one the other, the verticall angles be equall, and all the angles equall to foure right angles.

A

A tryangle.

Tryangles.

28 A tryangle is a right lined plaine contained vnder thrée angles, and thrée right lines.

29 Any two ſides of a tryangle are greater then the third ſide remaining. Ra.l.6.p.7.

30 If a right line in a tryangle be parallell to the baſe, it cutteth the ſéete proportionally, and contrariwiſe. Eu.l.6 p.2. and being parallell the angles be equall.

31 The thrée angles in a tryangle are equall vnto two right angles. Eu.l.1.p.32. Therefore

1 Any two angles in a tryangle are leſſer then two right angles.

2 The ſide of a tryangle being continued forth infinitly, the outward angle is equall to the two inward angles oppoſite, and greater by the ſame conſequence then any inward angle oppoſite.

32 If a tryangle haue equall ſéete, the angles at the baſe are equall and contrary. Eu.l.1.p.5.& 6. Conſequently

1 An equiangle triangle is alſo equilater, and contrary.

2 An angle of an equilater tryangle is as great as $\frac{2}{3}$ of a right angle. Ra.l.6.p.10. Conſ.3.

33 The greateſt ſide of a tryangle ſubtendeth the greateſt angle, and contrary. Eu.l.1.p.19.& 18.

34 Tryangles of equall height are in proportion as their baſes. Eu.l.6.p.1.

Circles.

Circles.

35 All Circles in Trygonometria are deuided into 360 equall parts, and ſo into minutes, &c. accordingly. So that the quadrant of a circle containes 90 degrées.

36 The giuen arke in the leſſer quadrant is the complement to the diſtance thereof from 90 as 40, the giuen arke is the complement to 50, the diſtance thereof from 90.

37 The arke in the greater quadrant is an exceſſe aboue 90, as 140 is an arke in the greater quadrant exceeding 90, 50 degrées.

38 All lines drawne from the center to the circumference be of equall length.

Chap. II.

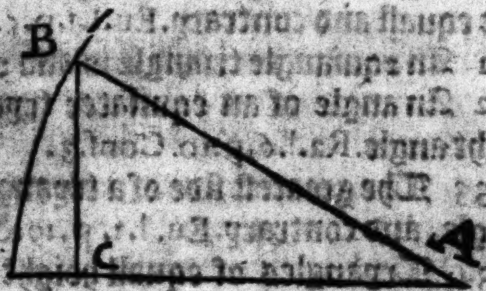
Hauing giuen you ſome neceſſary Geometricall inſtructions, for the better opening of your vnderſtanding, now ſhall follow the Axiomes of Trigonometria it ſelfe, which chiefely is effected by the rule of propoſition: the firſt Axiome ſhall teach what proportions ſhall be in the tryangles or parts thereof, afterward ſhall be declared, how thoſe Axiomes may be applied to vſe.

Axioma 1.

In plaine rectangled tryangles, any one of the three ſides may be put for the radius.

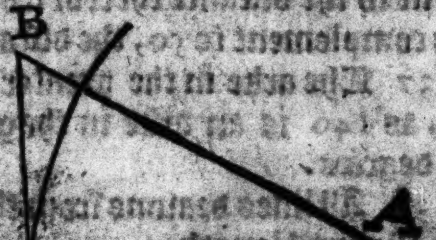
For

Firſt, if you put the ſide ſubtending the right angle for the radius, the ſides including the right angle are the ſines of the acute oppoſite angles,



As in the plaine tryangle A B C, if you put the ſide A B, ſubtending the right angle for the Radius, then B C, the leſſe ſide including the right angle is the ſine of the leſſer acute angle oppoſite thereto, as A B C, and the greater ſide A C including the right angle, is the ſine of the greater angle oppoſite as A B C.

2 If you put the greater ſide including the right angle for the Radius, then the leſſer ſide including the right angle is the Tangent, and the ſide ſubtending the right angle is the ſecant of the leſſer acute angle.

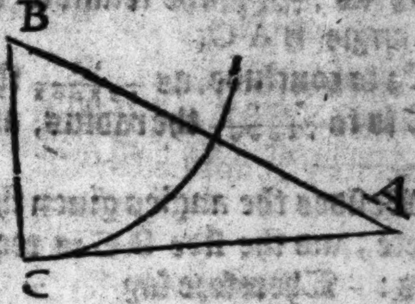


As if you put the greater ſide including the right angle A C for the Radius, then is the leſſer including line B C the Tangent of B A C, the leſſer angle oppoſite thereto, and A B, the line ſubtending the right angle, the ſecant of the ſaid acute angle.

3 If to conclude, you put the leſſe ſide including the right

angle for the Radius, the greater ſide including the right angle is the Tangent, and the ſide ſubtending the right angle is the ſecant of the greater acute angle.

As if you put the leſſe ſide B C for the Radius, then the greater ſide A C including the right angle, is the Tangent of yͤ greater acute angle oppoſite there to A B C, and the ſubtending ſide A B is the ſecant of the ſaid acute angle.



Conſectary 1.

Therefore in plaine right angled tryangles

The angles being giuen, the proportions of the ſide are had three manner of waies:

One ſide together with the angles being giuen, the reſt of the ſides are had after a threefold proportion, according to the ſide that you put for the Radius.

As in the plaine right angled tryangle propoſed A B C, the giuen angle A, is 30 degrees 20 min. and thereby B 59 degrees, 40 min. (for yͤ one acute angle is the complement to yͤ other, as you may gather Chapter 1, def. 30, therefore in plaine right angled tryangles, one of the acute angles being giuen, the reſt are likewiſe had) ſo as I ſay the angle at A is 30 degrees, 20 min. and at B 59,40 whereby the proportion of the ſides ſtand thus.

Either.

1	A B is the Radius.	100000
	B C the ſine of the acute angle B A C	50502
	A C the ſine of the acute angle A B C	86310

Or

2	A C, is the Radius.	100000
	B C, the Tangent of the acute angle B A C	58513
	A B, the ſecant of the ſaid acute angle	115861

Or to conclude,

3	B C is the Radius	100000
	A C, the Tangent of the acute angle A B C	17901
	A B, the ſecant of the ſaid acute angle	198008

Which is to ſay.

1 As $\frac{\text{AB}}{100000}$ the radius is to $\frac{\text{BC}}{50502}$ the ſine of the acute angle B A C.

2 Or, as $\frac{\text{AB}}{115861}$ the ſecant is to $\frac{\text{BC}}{58513}$ the tangent of the acute angle B A C.

3 Or to conclude, as $\frac{\text{AB}}{198008}$ the ſecant of the acute angle A B C is to $\frac{\text{BC}}{100000}$ the radius, and ſo of the reſt.

1 Beſides the angles giuen there is alſo giuen the ſide A B 4 feete, and the ſide B C is required how many feete it containes: Therefore ſay

Either.

1 As $\frac{\text{AB}}{100000}$ the radius, is to $\frac{\text{BC}}{505029}$ the right ſine, ſo is $\frac{\text{AB}}{24}$ feete the ſide, to A C 12 $\frac{12671}{100000}$ feete.

Or

2 As $\frac{\text{AB}}{115861}$ the ſecant, is to $\frac{\text{BC}}{58513}$ the tangent, ſo is $\frac{\text{AB}}{24}$ feet to B C 12 $\frac{17986}{115861}$ feete.

Or to conclude:

3 As $\frac{\text{AB}}{198008}$ the complement of the ſecant, is to $\frac{\text{BC}}{100000}$ the radius, ſo is $\frac{\text{AB}}{24}$ feet the ſide to B C 12 $\frac{23902}{198008}$ feete.

2 Likewiſe if the ſame ſide A B 24 feete were giuen, and the ſide A C required, Say

Either.

1 As $\frac{\text{AB}}{100000}$ the radius, is to $\frac{\text{AC}}{86310}$ the right ſine, ſo is $\frac{\text{AB}}{24}$ feet the ſide, to A C 20 $\frac{71444}{100000}$ feete.

Or

2 As $\frac{\text{AB}}{115861}$ the ſecant, is to $\frac{\text{AC}}{100000}$ the radius, ſo is $\frac{\text{AB}}{24}$ feete the ſide, to A C 20 $\frac{82776}{115861}$ feete.

Or to conclude.

3 As $\frac{\text{AB}}{198008}$ the complement of the ſecant, is to $\frac{\text{AC}}{170903}$ the tangent, ſo is A B 24 feete to A C $\frac{141465}{198008}$ feete.

3 In like manner, if the ſide A C 20 $\frac{71444}{100000}$ feete be giuen, and the ſide B C required: Say

Either

1 As $\frac{\text{AC}}{86310}$ the right ſine is to $\frac{\text{BC}}{505029}$, ſo is A C 20 $\frac{71444}{100000}$ feete, to B C 12 $\frac{16418}{86310}$ feete.

Or,

2 As $\frac{\text{AC}}{100000}$ the radius, is to $\frac{\text{BC}}{58513}$ the tangent, ſo is A C 20 $\frac{71444}{100000}$ feete, to B C 12 $\frac{12071}{100000}$ feete.

Or to conclude.

3 As $\frac{AC}{179901}$, the tangent of the complement, is to $\frac{BC}{100000}$ the radius, ſo is A C 20 $\frac{71444}{100000}$ feete, to B C 12 $\frac{26516}{179901}$ feete.

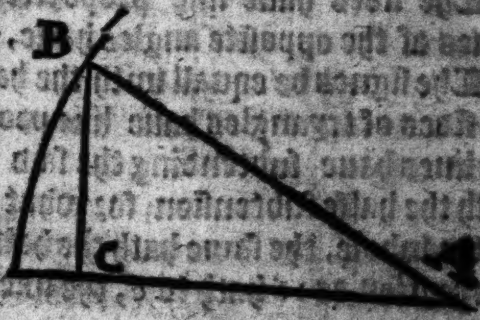
But the witty Artiſt ſkilfull in the vſe of this treatiſe of Trigonometria, will proportion his numbers in ſuch order that the Radius ſhall alwaies haue the firſt place, thereby to auoide the great labour in deuiding ſuch great numbers.

Conſectarie 2.

By the giuing of two ſides which ſoeuer they be, both the acute angles are obtained by a double proportion, according to the ſide that you appoint for the radius.

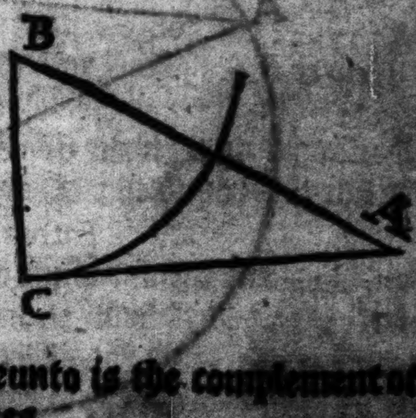
1 As in the plaine right angled tryangle A B C, if two ſides including the right angle be giuen, as A B and B C, the one being 5 feete, the other 3 feete, and the acute angles at A and B are required; Say

1 As $\frac{AB}{5\ Feet}$ is to $\frac{BC}{3\ feete}$ ſo is $\frac{AB}{100000}$ the radius, to $\frac{BC}{60000}$ the ſine of the angle B A C, anſwering to which ſine in the Table vpon the left ſide the page is 36 degrees, 52 minutes, and the laſt row in the Table vpon the right hand is 53 degrees, 8 minuts, the complement of A B C.



Or

2 As $\frac{BC}{3\ Feet}$ is to $\frac{AB}{5\ Feet}$, ſo is $\frac{BC}{100000}$ the radius to $\frac{AB}{166679}$ the ſecant of the angle A B C, to which ſecant vpon the right hand in the right Table anſweres 53 degrees, 8 minutes, and in the left margent in the lefte Table anſwering thereunto is the complement of the Angle 36 degrees, 52 minutes.



Likewiſe in the tryangle A B C, if there be giuen two ſides containing the right angle, as A C 4 feete, and B C 3 feete, and the acute angles B and A, be required, you may ſay

Either,

1 As $\frac{AC}{4\ feete}$ is to $\frac{BC}{3\ feet}$ ſo is $\frac{BC}{100000}$ the radius to $\frac{BC}{74991}$ the tangent of the angle B A C, the arke anſwering in the Table is 36 degrées, 52 minutes, and the complement of that angle is 53 degrées, 8 minutes.

The ſecond figure in the firſt Axiome ſerueth here.

Or,

2 As $\frac{BC}{3\ feete}$ is to $\frac{AC}{4\ feete}$ ſo is $\frac{BC}{100000}$ the radius to $\frac{AC}{133349}$ the tangent of the angle A B C, the arke anſwering to which tangent in the right table is 53 degrées, 8 minutes, and the complement of the ſayd arke in the laſt row leftwards in the left Table is 36 degrées 52 min.

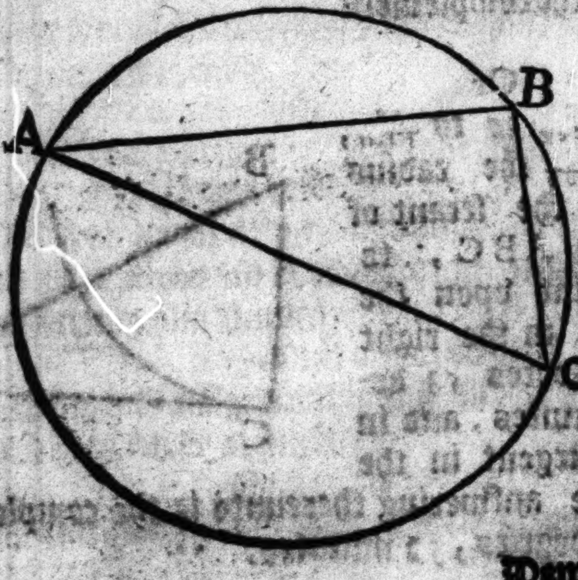
The third figure in the firſt Axiome, ſerueth here alſo.

Axioma 2.

In all kind of plaine tryangles

The ſides haue like proportion vnto the other, as the ſignes of the oppoſite angles haue, reſpecting the ſaid ſides.

The ſignes be equall with the halfe of the ſubtenſions, and the ſides of tryangles haue like proportion vnto the other as the lines haue ſubtending the ſaid angles: the like therefore hath the halfe ſubtenſion; for what proportion the whole hath to the whole, the ſame hath the halfe to the halfe; for the ſame proportion as 16 hath to 6, the like hath 8 to 3.



Demonſtrations

Demonſtration: if about the plaine tryangle A B C, there be circumſcribed a circle, the ſide A B is made a line ſubtending the angle A B C, that is the arke A B, which meeteth with the angle A C B; the ſide B C is made the ſubtenſion of the angle B A C, becauſe it meeteth with the angle A C B: to conclude, the ſide A C is made to ſubtend the angle A B C, that is the arke A C, becauſe it meeteth with the angle A B C.

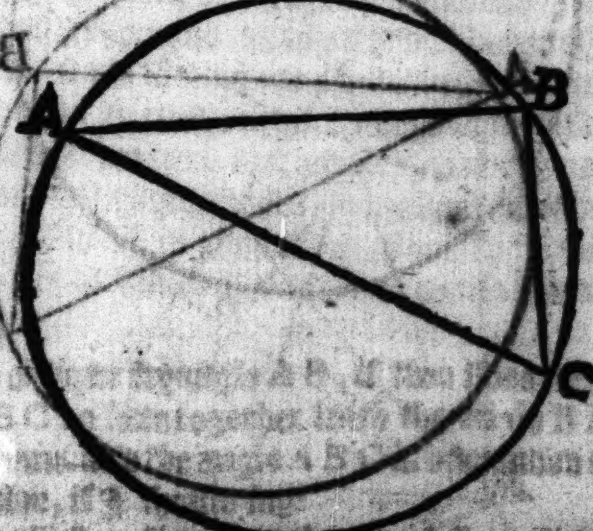
Therefore the ſide A B beares it ſelfe in ſuch proportion to the ſide B C, as the ſubtention of the angle A C B, doth to the ſubtenſion of the angle B A C, &c. which was required to be demonſtrated.

Conſectarie 1.

Therefore the angles being given, the proportion of the ſides be alſo found.

And by the conſequence.

Beſides, the angles hauing alſo one ſide, both the other ſides are eaſily obtained.



As in the plaine obliquangled tryangle A B C, the angle of A 20 degrees, 10 minutes, as C 60 degrees, 23 min. is given, and therefore B 99 deg. 27 min. is alſo given, then the proportion of the ſides be found thus.

A B 86935 the ſine of the angle A C B, 60 degrees, 23 min.

B C 34475 the ſine of the angle B A C, 20 deg. 10 min.

A C 98642 the ſine of the angle A B C, 99 deg. 27 min.

Wherefore if further there be given one ſide, as A B, 34 feete, the other ſides B C and A C, are alſo to be had: For

1 As $\frac{AB}{86935}$ is to $\frac{BC}{34475}$, ſo is $\frac{AB}{34\ feete}$ to B C 13 $\frac{42640}{86935}$ feete.

In like manner.

1 As $\frac{AB}{86935}$ is to $\frac{AC}{98642}$, ſo is $\frac{AB}{34\ feete}$ to A C 38 $\frac{50224}{86935}$ feete.

Vel tranſpoſitis terminis intermediis.

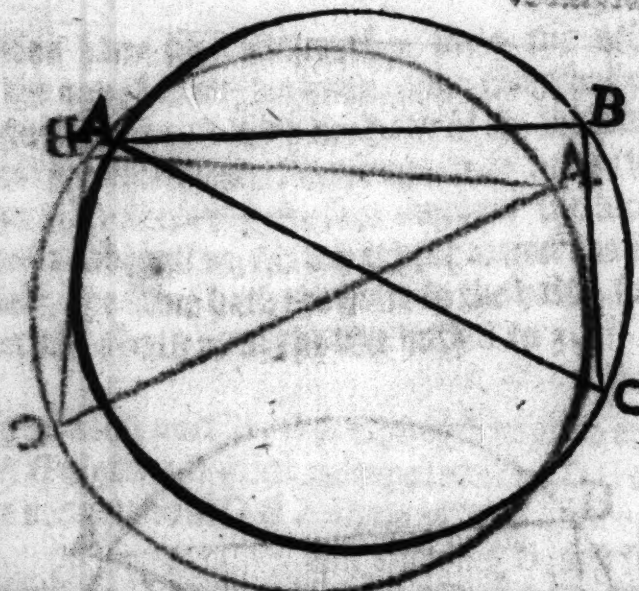
2 As $\frac{ACB}{86935}$ is to $\frac{AB}{34\ feete}$, ſo is $\frac{BAC}{34475}$ to B C 13 $\frac{42}{87}$ feete.

2 As $\frac{ACB}{86935}$ is to $\frac{AB}{34\ feete}$, ſo is $\frac{ABC}{98642}$ to A C 38 $\frac{50}{87}$ feete.

Conſectarie 2.

Two ſides of a tryangle being giuen, with an angle oppoſite to one of the ſaid ſides, to find the other ſide, and the other two angles oppoſite to the two ſides.

As in the oblique angled tryangle A B C, two ſides being giuen A B 34 feete, and B C 13 $\frac{42640}{86935}$ feete, with the angle A C B oppoſite to A B, containing 60 degrees 23 min.



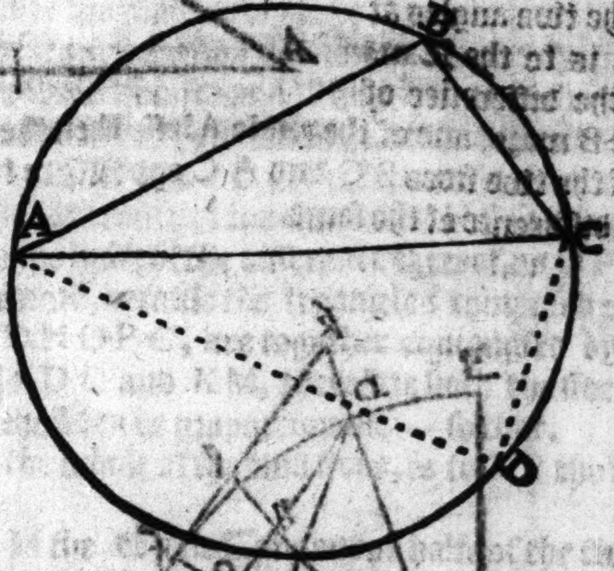
You ſhall alſo be brought to the knowledge of the angle A B C oppoſite to any other of the giuen ſides, to wit A C, for by the giuing of the angle A C B 60 degrees 23 min. the ſine of that angle 86935, is alſo had: Therefore I ſay, as A B the ſide 34 feete is to B C the ſide 13 $\frac{42640}{86935}$ feete, ſo is A B the ſine of the angle A C B 86935 to B C the ſine of the angle B A C 34475.

Vel tranſpoſitis terminis intermediis.

As $\frac{AB}{34\ feete}$ is to $\frac{ACB}{86935}$, ſo is B C 13 $\frac{42640}{86935}$ feete to $\frac{BAC}{34475}$.

To which ſine 34475 in the Table vpon the lefte hand in the left margent 20 gr. and 10 min. doth anſwere, therefore the angle B A C is 20 gr. 10 min.

Note, in the vſe of the former conſectary certaine doubts may ariſe, to wit: if there be giuen two ſides, whereof the one is the greater ſide, together with the angle oppoſite to the leſſer of the giuen ſides, and there is required the angle oppoſite to the greater of the giuen ſides, and for becauſe this angle may be acute or obtuſe, and ſo the ſame ſine ſerues to which you pleaſe, hauing obtained the ſine, it is a doubt to which angle it anſwereth.



As in the oblique tryangle A B, if two ſides be giuen A C 20 feet, and B C 10 feete together with the angle B A C 29 degrees and 59 min. and the angle A B C is demanded oppoſite to the greateſt ſide, if I ſhould ſay:

As the ſide B C 10 feete is to the ſide A C 20 feete, ſo is B C yͤ ſine of the angle B A C 49974 to A C to the ſine of yͤ angle A B C, for the ſine of A C is eaſily found 99947, but becauſe this ſine is as well the ſine of the acute angle A D C 88 degrees 8 min. as of the obtuſe angle A B C 91 degrees 52 min. it is doubtfull whether the obtuſe angle of 91 degrees 52 min. or the acute angle of 88 deg. and 8 min. be found by that ſine.

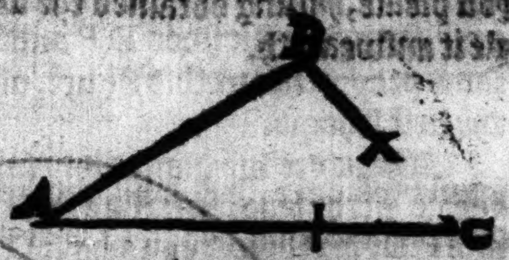
Neither can this doubt otherwiſe be reſolued, then by the doctrine before to find out the quantity of the ſaid vnknowen angle.

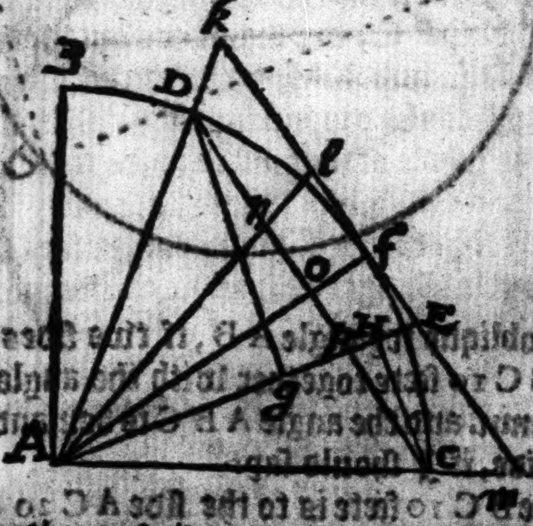
Axioma III.

In all kind of plaine tryangles.

As the whole of two ſides is to the difference of the ſame, ſo is the Tangent of the whole halfe of the two oppoſite angles, to the Tangent of the difference, that is, more or leſſe then the halfe.

Declaration: in the plaine obliquangled tryangle A B C, I ſay, that the tangent of the whole halfe of the two angles at A and B, is to the Tangent of the difference of the angle B more, and of the angle A leſſe then the halfe, as the whole of the two ſides B C, and A C oppoſite to thoſe angles, is to the difference of the ſame.





Demonſtration: deſcribe a quadrant A B C, and therein appoint the angles D A E and E A C equal to the halfe angles in the former ſcheme A B C, and B A C, and therein let be the whole halfe of thoſe two angles, which is heere contained in the angle D A C, let the halfe of that whole be D A F, or F A C, the difference of the angle D A E more then the halfe of D A F, or of the angle E A C, leſſe then the halfe of F A C, is the angle F A E. The ſubtenſion of the whole of thoſe two angles is the right line D C, the ſine of the angle D A E is D G, the ſine of the leſſer angle E A C is the right line C H; the Tangent of the whole halfe of the two tryangles is F N or F K, the Tangent of the difference leſſe. or more then the halfe is F E: now the tryangles G D P, and C P H, are equall by the Chapter 1, def. 26, ſo that we may inferre proportionall termes thus; as P D is to G D, ſo is P C to C H, as is proved 4. P. 6 Eucl. And ſo in the firſt figure.

As A C is to A B C, ſo is B C to B A C, by the third Axioma, therefore the ſides D P and P C, have in like manner the ſame proportion in this figure, as the ſides A C and B, have in the firſt ſcheme.

Wherefore we may boldly take the right line D C for the whole of the two given ſides A C and B C, and the partes D P and P C, for thoſe two ſides A C and B C: the which ſo being, N P is the difference of ye two ſides, but the ſides A C and B C in the firſt, and D P and P C in the ſecond ſcheme are given, therefore the difference of the ſame ſide N P is alſo given together with the halfe of the difference thereof, as O P.

Furthermore, becauſe the tryangles compoſed of A K L F E M and A D N O P C, are together equiangled by reaſon of the parallels D C and K M, therefore both the ſides and the ſegment of the ſides be proportionall:—ſo that,

As D C the whole of the two ſides, is to N P the difference of the ſame:

So is K M the double Tangent of halfe of the two angles to L E the double Tangent of the difference more or leſſe then the halfe.

Or

As O C the halfe of the whole of the two ſides, is to O P the halfe of the difference thereof:

So is F M, the Tangent of the whole halfe of the two oppoſit angles, to F E the tangent of the difference more, or leſſe then the halfe,

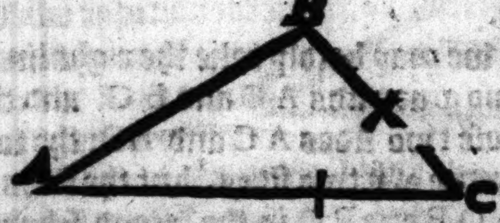
Or with more eaſe.

As the whole of the two ſides is to N P, the difference of the ſame, ſo is F M, the Tangent of the halfe of the two oppoſite angles, to F E the Tangent of the difference, more or leſſe then the halfe. For as the whole is to the whole, ſo is the parte to the parte: therefore as the whole K M is to the part L E, ſo is the halfe F M, to the halfe F E.

Conſectarium.

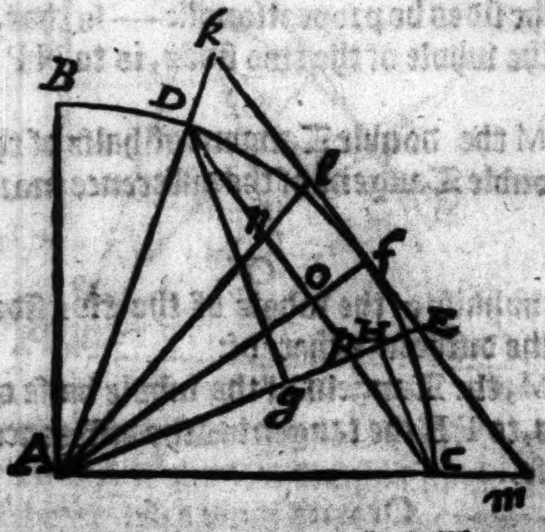
Therefore in plaine oblique angled tryangles, two ſides being giuen with the angle comprehended by the ſame, the other two angles are alſo found.

As in the plaine obliquangled tryangle ABC, by the giuing of the two ſides AC 5, and BC 3 ſitte together with the angle ACB 40 degrees, the other two angles ABC and BAC are found, thus.



The whole of the two giuen ſides is eight, the difference two.

The whole of the angles at A and B is 140 degrees by the Chap. 1, def. 30



The halfe of that whole is 70 grad. whoſe Tangent is 274747

Therefore I ſay,

As the two giuen ſides 8, is to 2 the difference of the ſame, ſo is the Tangent of the halfe of the oppoſite angles 274747 to 68685 the Tangent of the arke, 34 degrees, 29 min. the difference of the angle A leſſe, and of B more then the halfe.

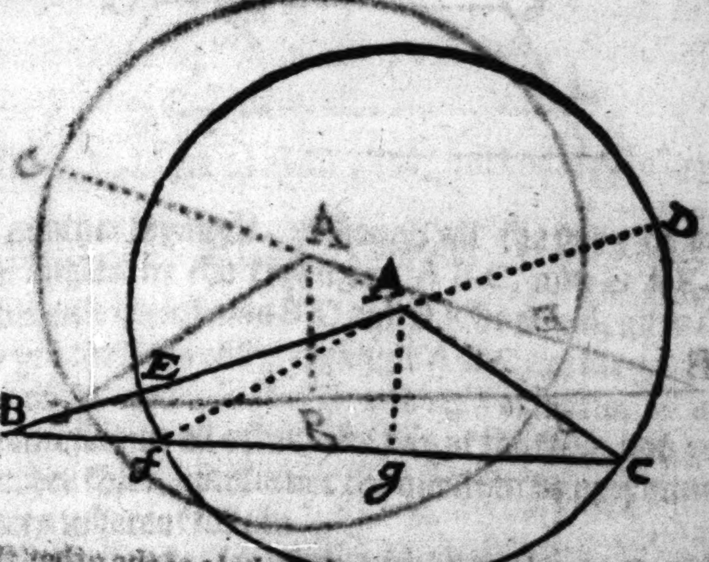
So that it is thus.

	deg.	mi.		deg.	mi.
	70	0		70 -	0
Subtr.	34	29.	Adde.	34	29.
The angle at A	35	31.	The angle A B C	104 -	29.

Axioma V.

In all kind of plaine tryangles,

As the greateſt ſide is to the other two ſides, ſo is the difference of the reſt of the ſides, to the ſegment of the greateſt ſide, which being taken away, the perpendicular falleth in the midſt of that which remaineth.



Declaration, let the obliquangle be A B C, whoſe leſt ſide is A C, yͤ greateſt B C, the radius of the leſſe ſide A C, the center A, whereon deſcribe a circle C D E F, cut in the other two ſides in points at F and E, making A C the radius or ſemidiameter: furthermore the ſide A B is produced to D, and B D is the whole of the two ſides, A B and A C, for A C and A D be equall. now E B is the difference of the ſides A B and A C, for A E and A C againe be equall by the Chapter 1. P. 37 —— ſo that I ſay: As C B, is to B D, ſo is E B to B F.

Next the right line F G, is cut into two parts by the perpendicular A G falling in the midſt thereof.

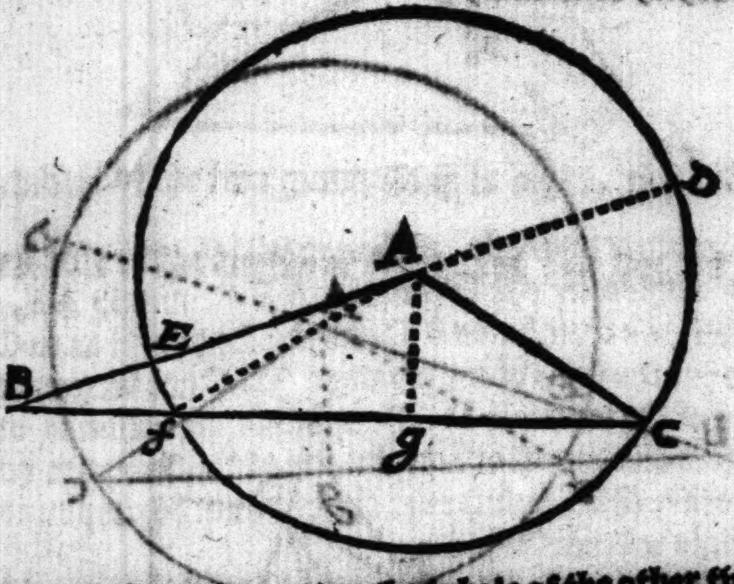
Conſectarie.

Therfore in plaine obliquangled tryangles, the thrée ſides being giuen, to find either of the ſegments in the greateſt ſide whereon the perpendicular falleth from the greateſt angle.

As in the plaine obliquangled tryangle A B C, there be the 3 ſides giuen, to wit.

A B, 20 féete.
B C, 22 féete.
A C, 13 féete.

And there is required the ſegment of the greateſt ſide B C, in the concourſe whereof, to wit, of B G and B C, the perpendicular falleth.



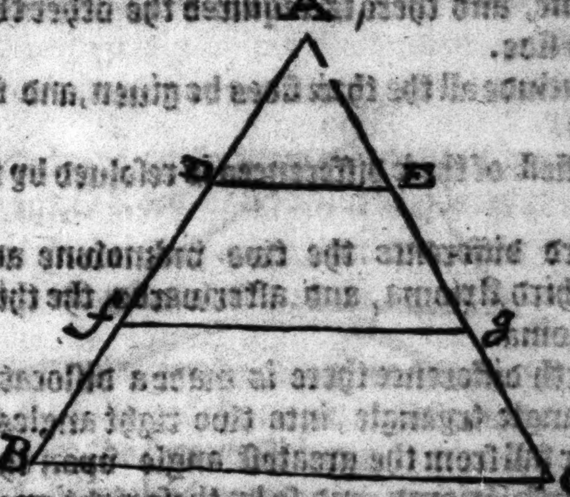
The greateſt ſide is 21 féete the whole of the other two ſides viz. of A B 20 féete, and A C 13 féete, is 33 féete, the difference 7 féete.

Therefore I conclude,

As $\frac{BC}{21\ \text{feete}}$ the greateſt ſide is to $\frac{BD}{33\ \text{Feet}}$ the whole of the other two ſides, ſo is $\frac{BE}{7\ \text{feet}}$ the difference of the other two ſides to $\frac{BF}{11}$ Feet, the which ſegment being taken from B C 21 féete, there remaines F C, 10 féete, whoſe one halfe F G, or G C is 5 féete, therefore G C is 5 féete, and G B 16 féete.

A Manuduction or the vſe of the former Axiomes.

In all tryangles there be 3 ſides and thrée angles, of which any thrée being giuen, the other thrée are found, & that after diuers waies as you may gather in the precedent Axiomes, onely excepting that you haue not onely thrée angles, and no ſide, for no ſide being giuen, no ſide is found; for becauſe the thrée angles of one tryangle may be equall vnto the thrée angles of another tryangle, although all the ſides be vnequall, as thrée angles in the tryangles A B C, and D A E, are equall, becauſe their baſes B C and B E be equal, as in Chap. 1 P. 29, & yet the ſides of the tryangle A B C are far greater then the ſides of the tryangle D A E: and this exception is onely in Trigonometria, in all other take any of the thrée, and you may haue ẏ other thrée, howſoeuer the queſtion be propounded, the differences whereof follow.



A plaine triangle, is either a right angle or an obliquangle.

1 In plaine right angled tryangles, either all the angles are giuen (to wit by the giuing of one of the acute angles) with one ſide, and the other two ſides be ſought.

2 Or there is giuen two ſides with one angle, to wit, the right angle, and the other two angles, and the third ſide is required.

Both the which are reſolued in the firſt Axiome.

In plaine obliquangled tryangles.

1 Either all the angles be giuen (which is as often as two be giuen, for the third is alwaies the complement vnto two right angles by the 30 P. Chap. 1) with one ſide, and there is ſought the other two ſides.

the angle D C B, which added to the angle B A C, and the whole taken from two right angles, there remaines the angle A B C.

And if furthermore you would know the ſide B C, by the 1. Axiom ſay, as the radius D C is to the ſecant of the angle D C B, ſo is the ſide D C, to the ſide B C.

¶ Thus farre of the dimenſion of tryangles by ſines, tangents, and ſecants, which I haue for the moſt part drawne from the doctrine of *Bartholo. Pitiſcus Grunbergenſ.* a forraine moderne writer, hoping you will take pleaſure in the application thereof to the ſingular vſe of the Geodeticall ſtaffe.

By this Sinicall doctrine may you find the ſides, diagonals and perpendiculars in any figure, and ſo thereby meaſure fields, woods, countries, &c. as in the ſixt booke.

The end of the first part of Trigonometria.

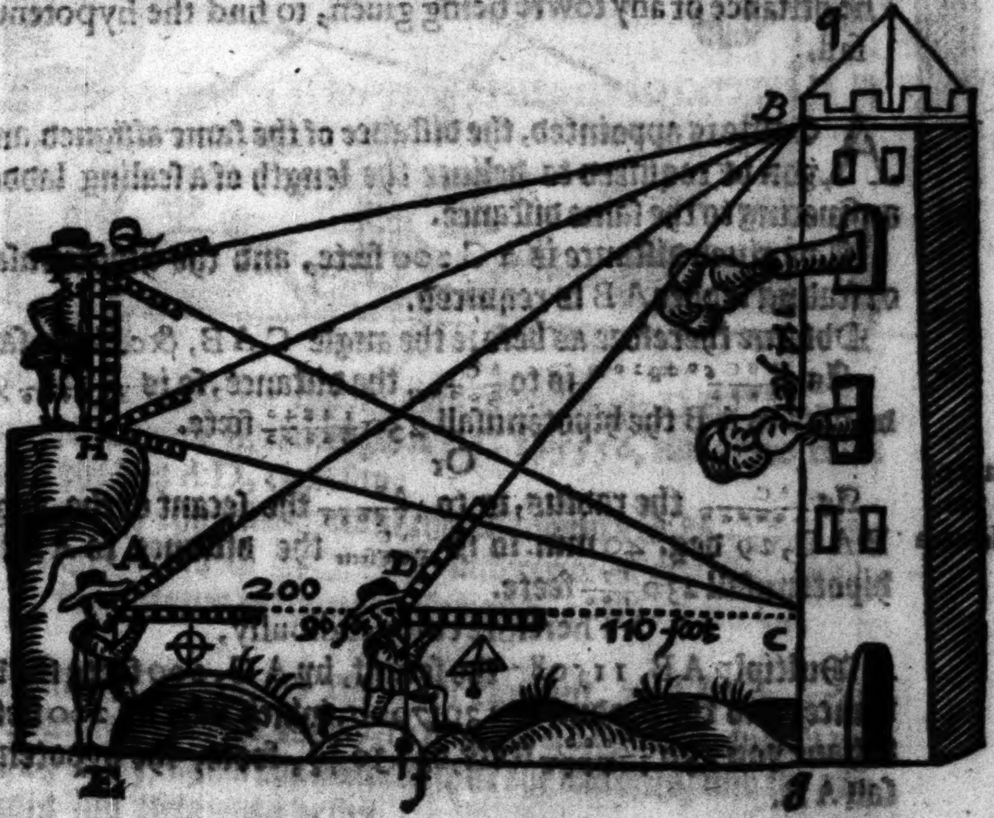
TRIGONOMETRIA THE SECOND PART.

Containing Altimetria and Longimetria, by Sines, Tangents and Secants.

Problema 1.

The diſtance of any Turret, &c. being giuen, to finde the altitude.

LEt the Turret be B G, and let the giuen diſtance be A C, or E G 200 feete, and you deſire to know the altitude of the battlement of the ſayd Turret B, aboue the eye of the obſeruer A, or C: You ſhall therefore by your ſtaffe, as in the ſecond booke, Chapter 4, or by your Topographicall Glaſſe, or ſome ſuch Inſtrument, obſerue the



angle

2 Or two ſides is giuen with the angle oppoſite vnto one of the giuen ſides, and there is required the angle oppoſite to the other of the giuen ſides, together with the third ſides.

3 Or there is giuen two ſides with the angle comprehended by the ſame, and there is required the other two angles with the third ſide.

4 Or to conclude all the thrée ſides be giuen, and the angles be all required.

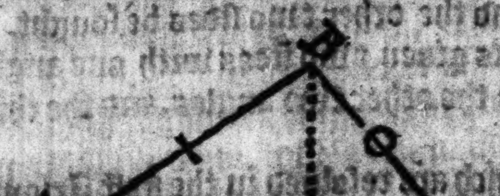
The two firſt of theſe differences is reſolued by the ſecond Axioma.

In the third difference the two vnknowne angles are found by the third Axioma, and afterwards the third ſide by the ſecond Axioma.

In the fourth difference there is made a diſlocation of the plaine obliquangle tryangle, into two right angles, letting a perpendicular fall from the greateſt angle vpon the greateſt ſide, by the fourth Axioma, and ſo by theſe right angled tryangles euery angle is found by the firſt Axioma.

¶ But the three former differences may be reſolued by the firſt Axioma, if ſo that from any vnknowne angle vpon the ſide oppoſite thereto, a perpendicular be let fall, happening within or without the tryangle, according as the caſe ſhall require, & thereby the obliquangled tryangle is conuerted into two tryangles; whether the perpendicular fall within or without the tryangles

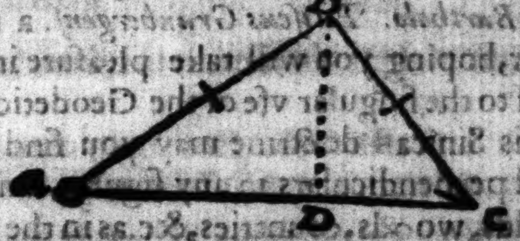
1 As if there be giuen this proportion; as A B the ſine of the angle A C B, is to B C, the ſine of the angle B A C, ſo is A B the ſide to B C the ſide by the ſecond Axioma.



To the ſame effect you may ſay by the firſt Axioma:

1 As A B the radius is to B D, the ſine of the angle B A D, ſo is A B the ſide to B D E the ſide.

Secondly as B D the radius, is to B C the ſecant of the angle D B C (which is the complement of the angle B C D) ſo is B D the ſide to B C the ſide.



2 If this proportion be giuen, as A B the ſide is to C B the ſide, ſo is A B the ſine of the angle A C B, to B C the ſine of the angle B A C by the ſecond Axioma.

After the ſame manner may you ſay.

Firſt, as B C the radius is to B D the ſine of the angle B C D, ſo is B C the ſide to B D the ſide.

Secondly, as B D the ſide, is to A B the ſide: ſo is B D the radius to A B the ſecant of the angle A B D, whoſe complement is the angle B A D, which angle B A D added to the angle D B C, maketh the angle A B C:

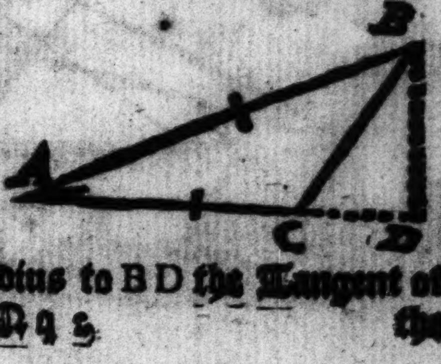
3 Laſtly, if there be ſuch a proportion as this giuen:

As the whole of the ſides A B and A C, is to the difference of the ſame, ſo is the Tangent of the halfe of the angle A B C, and A C B to the Tangent of the difference, being more or leſſe then the halfe, as by the third Axioma.

To the ſame effect may you ſay by the firſt Axioma:

Firſt, as A B the radius, is to B D the ſine of the angle B A D, ſo A B the ſide to D B the ſide.

Secondly, as A B the radius is to A D the ſine of the angle, A B D, ſo is A B, the ſide to A D the ſide, which being taken from the ſide A C, the ſide D C remaineth.



Thirdly, as D C the ſide, is to the ſide B D: ſo is D C, the radius to B D the Tangent of the angle D C B, which added to the angle B A C, and the whole taken from two right angles, there remaines the angle A B C.

And if furthermore you would know the ſide B C, by the 1. Axiom ſay, as the radius D C is to the ſecant of the angle D C B, ſo is the ſide D C, to the ſide B C.

¶ Thus farre of the dimenſion of tryangles by ſines, tangents, and ſecants, which I haue for the moſt part drawne from the doctrine of *Bartholo. Pitiſcus Grunbergenſ.* a forraine moderne writer, hoping you will take pleaſure in the application thereof to the ſingular vſe of the Geodeticall ſtaffe.

By this Sinicall doctrine may you find the ſides, diagonals and perpendiculars in any figure, and ſo thereby meaſure fields, woods, countries, &c. as in the ſixt booke.

The end of the firſt part of Trigonometria.

TRIGONOMETRIA THE SECOND PART.

Containing Altimetria and Longimetria, by Sines, Tangents and Secants.

Problema 1.

The diſtance of any Turret, &c. being giuen, to finde the altitude.

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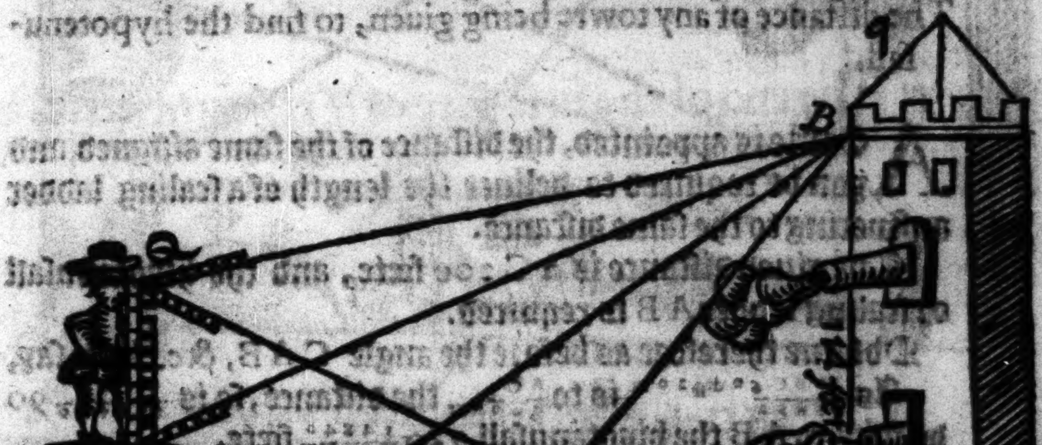


angle of altitude C A B 29 degrées, 40 min. and thereby get the angle A B C 60 deg. 20 min. by the ſecond booke Chap. 15. Then ſay.

As $\frac{AC}{86892}$ the ſine of the angle $\frac{ABC\ 60\ deg.\ 20\ m.}{200\ feete}$ is to $\frac{BC}{49495}$ the ſine of the angle B A C 29 deg. 40 min, ſo is $\frac{AC}{200\ feete}$ to B C 113 $\frac{80204}{86892}$, which is well néere 114 féete.

Or

As $\frac{AC}{100000}$ the radius, is to $\frac{BC}{56968}$ the tangent of ye angle B A C 29 degrées, 40 min. ſo is $\frac{AC}{200\ feete}$ to B C 113 $\frac{932}{1000}$ feete: that is néere 114 féete.

Or to conclude.

As $\frac{AC}{175556}$ the tangent of A B C 60 degrées, 20 min. is to $\frac{BC}{100000}$ the radius, ſo is $\frac{AC}{200\ feete}$ to B C 113 $\frac{163872}{175556}$ feete.

All theſe be referred vnto the firſt Axioma:

But vulgarly.

Multiply the tangent B C 56961 by 200 feete, the diſtance of A C, and the product is 113 (92200, which part by the totall ſine 100000 (as in the end of this treatiſe you be eaſily taught to do) ſo haue you 113 $\frac{922}{1000}$ féete, the height of B C.

Probleme 2.

The diſtance of any towre being giuen, to find the hypotenuſall.

A Caſtle is appointed, the diſtance of the ſame aſſigned, and you be required to deliuer the length of a ſcaling ladder anſwering to the ſame diſtance.

The giuen diſtance is A C 200 féete, and the hipotenuſall or ſcaling ladder A B is required.

Obſerue therefore as before the angle C A B, &c. then ſay,

As $\frac{ABC\ 60\ deg.\ 20\ m.}{86892}$ is to $\frac{AC}{200\ feete}$ the diſtance, ſo is $\frac{ACB}{100000}$ 90 degrées to A B the hipotenuſall 230 $\frac{14340}{86892}$ féete.

The figure of the firſt probleme ſerueth here.

Or

As $\frac{AC}{100000}$ the radius, is to $\frac{AB}{115085}$ the ſecant of the angle B A C, 29 deg. 40 min. ſo is $\frac{AC}{200\ feete}$ the diſtance to A B the hipotenuſall 230 $\frac{17}{100}$ feete.

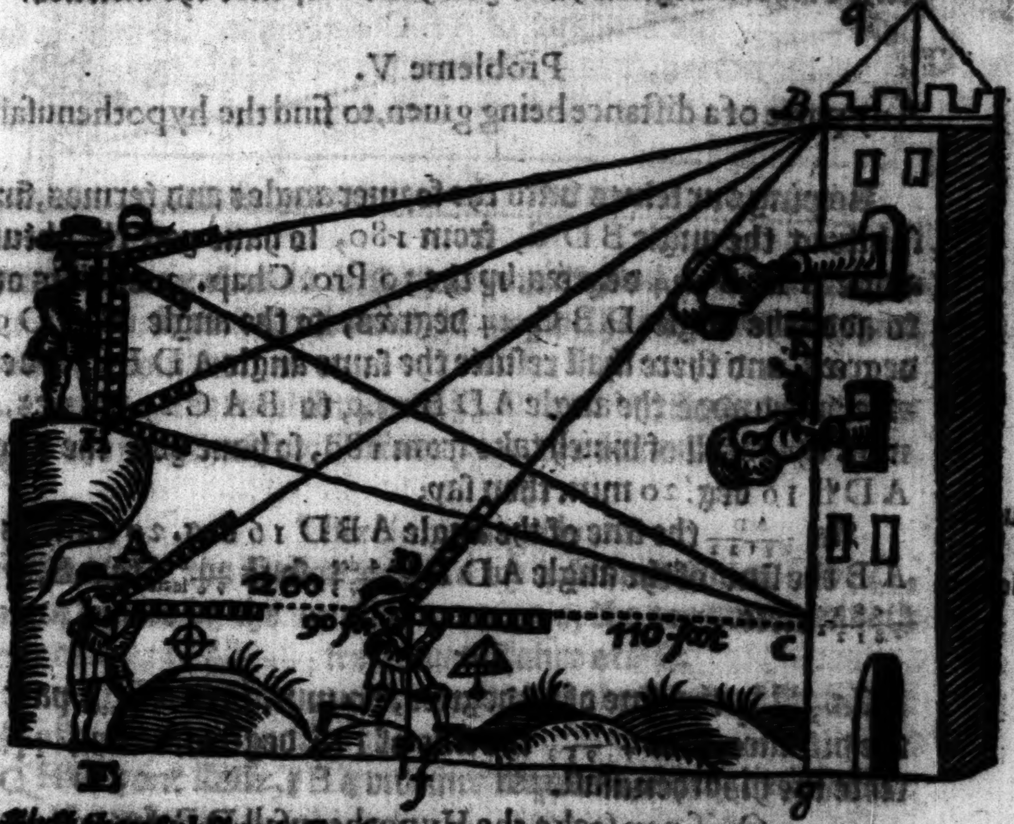
Therefore compendiouſly,

Multiply A B, 115085 the ſecant, by A C, 200 féete the diſtance, and the product is 23017000, which part by 200 féete, ſo haue you 230 $\frac{17000}{100000}$ feete, or 230 $\frac{17}{100}$ feete, the hypotenuſall A B.

Probleme 3.

Any part of the diſtance of a tower being giuen, to find the reſt.

Let a part of the diſtance A C be giuen, as A D, or E F 90 feete, and let the reſt of the diſtance be required, to which you cannot come to meaſe by reaſon of waters, ditches, &c. therefore at the firſt ſtation A, obſerue the angle B A C 29 degrees, 40 min. and at the ſecond ſtation F, the angle B D C, and ſo by ſubſtraction from 90 by the 30 Prop. Chap. 1. you haue the angle A B C, 60 deg. 20 min. and the angle D B C 44 degrees.



The figu
the firſt
bleme ſe
here.

First then ſubſtract the tangent of the angle D B C 96568, from the tangent of the angle A B C 175556, and there reſts 78988 the line A D, then ſay

As $\frac{AD}{78988}$ the difference of the Tangents is to $\frac{DC}{96568}$ the leſſer tangent, ſo is $\frac{AD}{90\ feete}$ the difference of the ſtations to $\frac{DC}{110\ feete}$ the diſtance of the neere ſtation, viz. of D from C.

Therefore

Multiply D C 96568 the leſſer tangent, by A D 90 feete, the difference of the ſtations, ſo haue you 8691120, which diuide by A D, 78988 the difference of the ſtations, and the quotient is 100 feete your deſire.

Prob.

Probleme IIII.

Any parte of a diſtance being giuen, to find out the altitude.

As $\frac{AD}{[illegible]}$ the difference of the Tangents is to $\frac{BC}{100000}$ the radius, ſo is $\frac{AD}{90\ feete}$ the difference of the ſtations to $\frac{BC}{114\ feete}$ feete the altitude.

Therfore.

Multiply the totall ſine 100000 by the difference of the ſtations 90 feete, ſo haue you 9000000, which parte by difference of the Tangents, and you haue 114 feete the altitude.

Probleme V.

Any parte of a diſtance being giuen, to find the hypothenuſall.

Keeping our ſelues vnto the former angles and termes, firſt ſubſtract the angle B D C, from 180, ſo haue you the obtuſe angle A D B 134 degrees, by the 30 Pro. Chap. 2. which is one to adde the angle D B C 44 degrees, to the angle B C D 90 degrees, and there ſhall reſulte the ſame angle A D B 134 deg. afterward adde the angle A D B 134, to B A C 29 degrees, 40 min. the totall of which take from 180, ſo haue you the angle A D B 16 deg. 20 min. then ſay:

The figure of the firſt probleme ſeemeth here.

As $\frac{AD}{28122}$ the ſine of the angle A B D 16 deg. 20 min. is to A B the ſine of the angle A D B $\frac{134\ deg.}{71937}$ ſo is $\frac{AD}{90\ feete}$ to A B, 230 $\frac{491}{28122}$ feete.

Or

As $\frac{ABD}{28122}$ the ſine of 16 degrees, 20 min. is to $\frac{AD}{90\ feete}$ part of the diſtance, ſo is $\frac{ADB}{71933}$ the ſine of 134 degrees, to 234 $\frac{401}{28122}$ feete the hypothenuſall.

Or if you ſeeke the Hypothenuſall D B, ſay

As $\frac{AB}{28122}$ is to $\frac{29\ deg.\ 40\ m.}{49497}$ ſo is $\frac{AD}{90\ feete}$ to D B 154 $\frac{[illegible]}{[illegible]}$ feete.

Or

As $\frac{ABD}{28122}$ is to $\frac{AB}{230\ feete}$ ſo is $\frac{BAD\ 29\ deg.\ 40\ m.}{49495}$ to D B 158 $\frac{12374}{28122}$ feete.

Probleme 16.

To ſeeke any kind of diſtance at one ſtation.

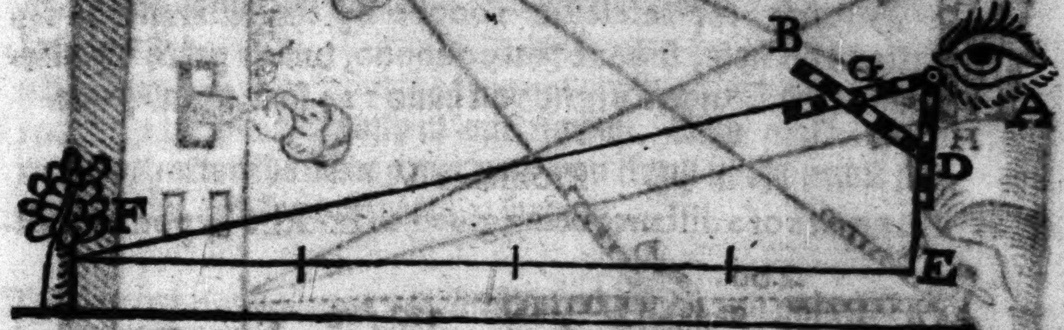
Let the diſtance be propoſed and your ſtation aſſigned, from which you may not depart, where plant your hollow ſtaffe, as you ſée cauſe, which done, you are to conſider thrée things.

1 If the marke whoſe diſtance is required, lye leuell with your foote or no.

2 If not leuell, whether aboue the leuell.

3 Or below the leuell of your foote.

1 If the diſtance deſired lye leuell with your foote, as F E, you ſhall firſt obſerue the angle F A E 75 deg. 58 min. Now



for the more eaſe, it is beſt that your ſtaffe A E ſtand perpendicular, ſo ſhall A E F be a right angle; the angle A being had, you may conclude.

As $\frac{AE}{100000}$ the total ſine, is to $\frac{FAE\ 75\ deg.\ 58\ m.}{400086}$, the tangent, ſo is $\frac{AE}{4\ feete}$ the length of my ſtaffe to $\frac{EF}{16\ feete}$ the diſtance.

Therefore vulgarly,

Multiply the ſecant 400086 by 4, ſo haue you 16(00344, which deuide by the totall ſine 100000, the quotient yéeldeth your deſire: 16 $\frac{344}{100000}$ feete, the diſtance of F E.

2 If the diſtance required lye aboue the leuell of the lower end of your ſtaffe, worke thus.

Q H is your ſtaffe, & B a diſtance required, which lieth higher then H my feete.

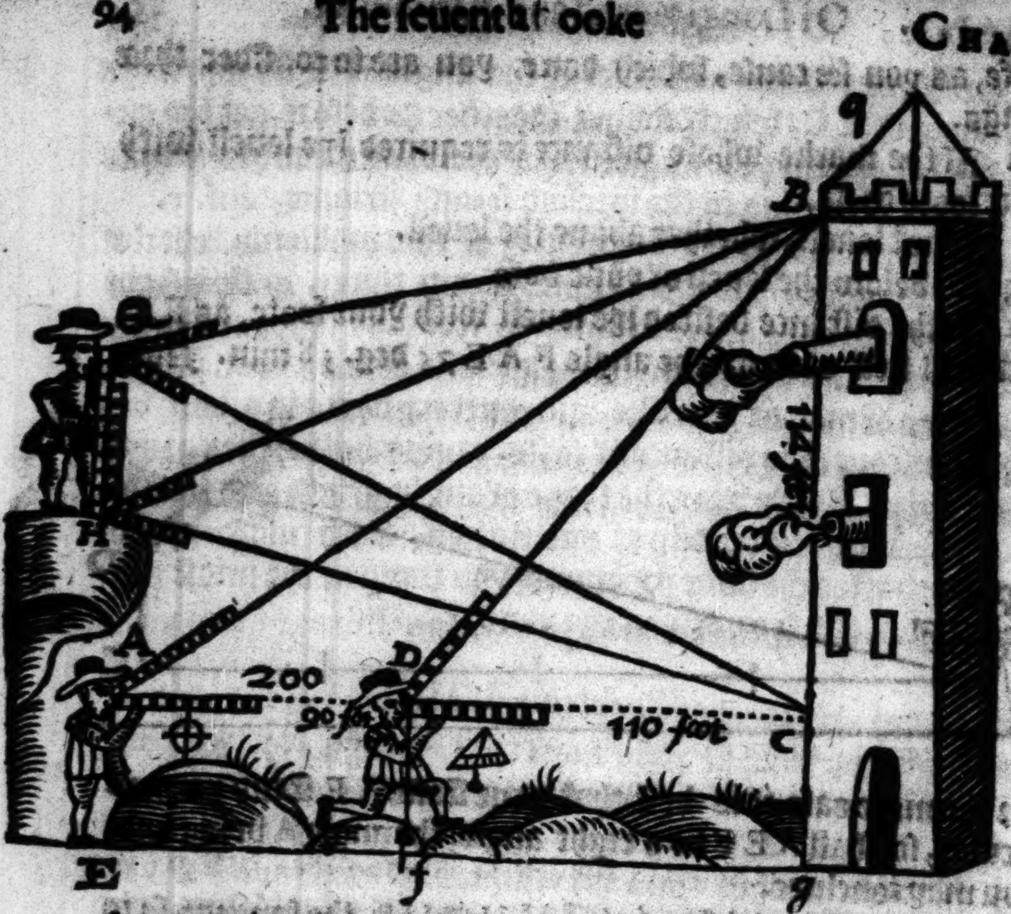
Therefore I ſéeke the angle B Q H 101 deg. then I go to H the foote of my ſtaffe, and there obſerue the angle B H Q 67 degr. by adding theſe two angles together, and taking the totall from 180, I haue the angle Q B H 12 deg. then I conclude by the 2 Axioma, Conſect. 1.

As $\frac{QBH\ 12\ deg.}{20791}$ the right ſine is to $\frac{QHB\ 67\ deg.}{92050}$ the ſine of the ſayd angle, ſo is $\frac{QH}{4\ feete}$ the length of my ſtaffe to Q B 17 $\frac{1579}{20791}$ feete, the diſtance.

By the ſame Axiome may you find the line H B: for

As $\frac{HBQ\ 12\ deg.}{20791}$ is to ẏ ſine of the angle $\frac{HQB\ 101\ deg.}{98163}$ (or the ſine

of



of 79 degrees, the complement of 101 deg) ſo is $\frac{Qh}{4\ \text{feete}}$ the length of the ſtaffe to H B 18 $\frac{18410}{20791}$ feete.

Or

As 20791 is to, 4, ſo is 98162 to the diſtance H B, your deſire.

Therefore vulgarly

Multiply 98162 by 4. the product whereof is 392648, which parte by 20791, and the quotient is 18 $\frac{18410}{20791}$ feete.

Thus of any ſuch like queſtion, the ſecond Arioma will direct you plainely.

Thirdly, before you were placed vpon the top of ſome cliffe or rocke, where you could not ſtirre to meete an ordinary ſtationary line, and yet were required to expreſſe the diſtance of the toppe of a Turret lying farre aboue your feete.

Now here alſo are you placed vpon the like rocke where you haue no liberty to ſtirre any way from the place you be in, neither to ſeeke the deepeneſſe of the ſaid rocke with a plumbe line to make a ſtationary line of, (as in ſuch caſes the order is) nor to goe any way at all, and yet are required to deliuer the true diſtance of the baſe of a Turret that lyeth farre below the leuel of your feete, which to doe.

Erect your ſtaffe and obſerue the angle H Q C, and there the angle Q H C, which adding together as before, get the angle H C Q, hauing the angles ſeeke their ſines, and ſo worke as before, according to the foreſaid ſecond Axiome, conſ. 1.

And here obſerue the ſingularity of this probleme, whereby you are taught to ſeeke the diſtance of any thing, within ſight at one ſtation howſoeuer ſituate, as from the toppe of a caſtle or rocke or ſuch like to deſcry the diſtance of ſhips vpon yͤ ſeas, of armies of men or ſuch like, and contrary being in a low valley, to diſcouer the diſtance of forts, camps, bulwarkes or any other obiect ſituate vpon the toppe of any high hill, and that directly, ſpeedily and readily at one ſtation, with moſt approued truth after the ſame order may you ſtand in the midſt of any medow, and ſpeedily plat the ſame &c.

Probleme VII.

To ſeeke the diſtance betwixt any two townes, any two ſhips vpon the ſeas, or any other inacceſſible obiects whatſoeuer.

This probleme is performed after this manner, firſt get the diſtance of each towne from you by the 6 probleme, and then obſerue the angle at your ſtation, ſo haue you an angle, & his two containing ſides, then may you find the third ſide, & the other two angles diuers waies by my doctrine of tryangles.

And ſo referring all other kind of Altitude, Longitude, Latitude or profundities to the diſcreete carriage of the reader, ſince they be but relatiues to what is ſaid before. Indeed we might inuent and draw diuerſe kinds, according to the ſituation of the obiect, & ſo increaſe the booke, & confound the memory, but the whole ground of all that can be deuiſed or inuented is already ſet downe, and therefore I preſume that no right lined tryangle howſoeuer ſituate, ſhall happen, whoſe ſides you ſhall be ignorant of, if you doe but well obſerue my doctrine in Trygonometria.

Note

¶ And here let it be noted that when the totall ſine is the firſt number in proportion, you may auoide deuiſion, and if it be not, you may ſo order the propoſition, that it ſhall be in all right angled tryangles, as in the firſt Axiome, for if the radius be not in the firſt place, then either the right ſine, the Tangent, or the ſecant is, all which the firſt Axioma reſolueth, ſo that you may make which ſide you pleaſe the radius; therefore when I ſay, but compendiouſly, as in the end of the firſt probleme, hauing multiplied the ſecond number by the laſt, as 56961 in 200, the product is 113, (92200: and where you ſhould deuide this number by the totall ſine, you neede but cut off ſo many figures from the product vpon your right hand, as there be cyphers in the totall ſine as you ſee before, ſo is the three figures vpon your left hand the quotient, and the fiue figures vpon your right hand the remainder; and ſo muſt you deale in al ſuch kind of works where the total ſine is deuiſor.

	The numbers to be multiplied.	56961
		200
Example	The product after multiplication - -	113(92200
	The totall ſine	100000
	The quotient	113
	The remainder.	92200

And here note further, when I ſay, as ſuch a number is to ſuch a one, &c. ſo is ſuch a one to ſuch a one &c. you muſt worke by the rule of three, to find out the numbers required.

As for the purpoſe:

As $\frac{AB}{2}$ is to $\frac{AC}{3}$ ſo is $\frac{CD}{4}$ to $\frac{DF}{6}$, therefore

Multiply A C, the ſecond number in proportion by C D, the third number, to wit three in foure, ſo haue you twelue, which parte by A B 2, the firſt number in proportion; ſo is the quotient D F; or the fourth in proportion viz, 6 the remainder; and thus of any other, and this in briefe is the golden rule or rule of three.

The deſcription and vſe of the Canon or Table for the dimenſion of tryangles, by ſines, Tangents, and ſecants, according as I haue *newly calculated the ſame.*

To auoid tediouſneſſe in fractions, as alſo for that few fractions are preciſely true, Authors haue deuiſed to deuide the ſemidiameter of a circle into a certaine number of equal parts, whereby they expreſſe ye true quantity of any arch; & the more partes the ſemediameter is deuided into, the truer is your worke. Regiomtonanus uſed 6,000,000, equall parts, and *Radium particularum* 60,000,000, 000. Rheticus made the ſemidiameter to containe 10,000, 000, 000, and *Radium particularum*, 1,000, 000,000, 000, 000, but with us 100, 000, equall partes ſhall ſuffice, according unto which there be tables of ſines calculated by Wittikineus for dials, but not after this method.

2 In this doctrine crooked or circular lines be reduced to right lines.

3 Curued lines are reduced unto right lines by the definition of quantity, which they haue, being applied to a circle in reſpect of the radius.

4 Any right lines being applied to a circle is called a ſubtention, which may be Sines, Tangents, or Secants.

5 A ſubtention is a right line inſcribed in a circle deuiding the whole circle into two ſegments, and in like manner ſubtending both thoſe ſegments.

9 A ſubtention is great or not great.

7 The great ſubtention is a line, which deuides the whole circle into two equal parts, and therefore doth ſubtend both the ſemicircles, as the right line G C, which is alſo the diameter.

8 A ſubtention not great, is, which deuides the circle into two unequall ſegments, ſubtending them both, as the right lines I B doth, doth ſubtend the leſſer arke in the ſemicircle I F B, and alſo the greater arke in the ſemicircle, as I H B.

9 A ſine is right or verſed.

10 A right ſine is the halfe ſubtention of a double arke, as the right ſine of the arke B C, or B G is the line D E, the halfe ſubtention of the double arke B C D or B G D, which the line B E D doth ſubtend.

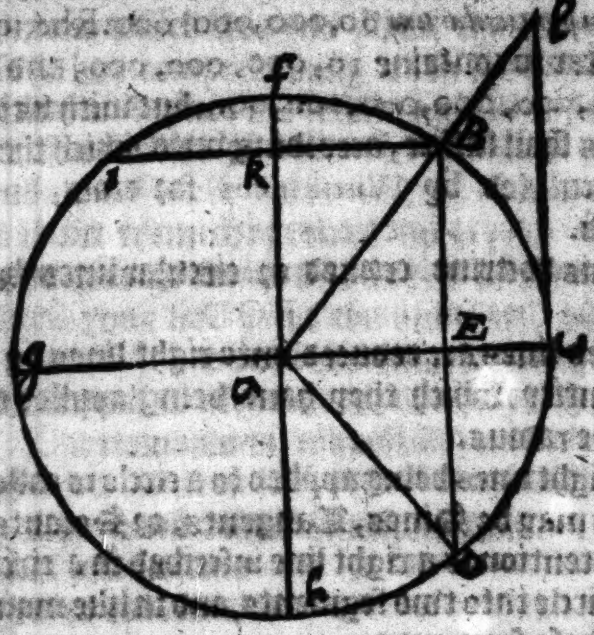
Conſectary.

1 Therefore the right ſine of the arke in the leſſer or greater quadrant euen to the ſemicircle be all on.

As the right ſine of the arke B C and B G, be all one to the right line B E, because it is the halfe of the right line B E D, which doth as wel ſubtend the arke B G D, as the arke B C D

2 So that when we ſay the complement of the right ſine, there is onely meant the complement of the right ſine in the leſſer quadrant.

As the complement of the right ſine B C, to wit B F is the right line B K.



Thirdly, euery right ſine falleth perpendicular vpon the diameter from the terme of the giuen arke, as B E.

Fourthly, the right ſine of the complement is equal ŷ to radius or ſegment of the diameter intercepted betwixt the right ſine of the arke and the center, as the right ſine of the complement B F viz. B K is equall to E A.

11 *Sinus verſus* a verſed ſine is the ſegment of the diameter intercepted betwixt the right ſine and the circumference.

As the verſed ſine of the arke B C is the ſegment of the diameter E C, and *ſinus verſus* of the arke B G, is the ſegment of the diameter G F.

12 Therefore of verſed ſines ſome be great, others leſſe.

13 *Sinus verſus maior* is the verſed ſine of the arke in ŷ greater quadrant as G E, is the verſed ſine of the arke G F B in the greater quadrant.

14 *Sinus verſus minor*, is the verſed ſine of the arke in the leſſer quadrant, as E C of the arke B C.

15 A Tangent is a right line meeting with the ſecant of the one terme of an arke falling perpendicular vpon the diameter, by the other terme of the arke.

Or a Tangent is a right line ſtanding perpendicular vpon the extreme of a diameter at the one terme of a giuen arke, and produced infinitely, vntill it interſect with the ſecant of the ſaid arke, as L C is the Tangent of the arke B C.

16 A ſecant is a right line produced from the center by the terme of a giuen arke vntill it touch the Tangent, as A L is the ſecant of the arke B C;

17 A Tangent is ſo called, for that it toucheth the circumference. A ſecant is ſo called for that it cuts the ſame circumference.

18 *Cordus* a chord is a circle cutting the totall ſine at right angles extended from the one terme of an arch vnto the other, as B D is the chord of the arch B C D.

19 Euery cord is a double ſine.

20 the greateſt chord that may be in any circles is the diameter, and the greateſt ſine the ſemidiameter.

21 The Tables of Sines, Tangents, and ſecants extend not beyond 90 degrées, for the right ſines of the greater and leſſer quadrant be all one by the 10 def. as for Tangents and ſecants they neuer exceed the quadrant of a circle by the 15 and 16 def.

1 To come vnto the tables themſelues, firſt know, that vpon the ſides of euery page there be placed foure tables it would be but vaine to make ample relation, ſince that the ſuperſcriptions be plaine, onely the difficultneſſe is in the degrées and minutes.

2 Therefore you muſt note, that we in this calculation, haue two kind of quadrants, and thereby two kind of arkes, as the arke of the leſſer quadrant, which cannot excéed 90 degrées, and the arke in the greater quadrant which may be 180 degrées.

3 The degrées of any arke in the leſſer quadrant to 45, are placed vpon the right hand in the toppe of euery table in great figures, ſo that euery table hath one of theſe deg. the min. anſwering to theſe deg. as in the firſt colum or row, vnder theſe deg. proceeding by 5, as 0. 5. 10. 15. &c.

4 The minutes are ſet by 5, becauſe vpon our inſtruments (notwithſtanding my exact deuiding of the circle by helpe of Iſoſceles tryangles) we cannot put a ſenſible difference in leſſe diuiſions, and therefore we were content to draw our tables according vnto a deg. deuided into 12 equall parts, euery parte containing 5 min. for it is vaine to deliuer quantities more preciſe in figures then we can, finding it by obſeruation, for what would the ſine or ſecant of thrée min. auaile, vs when inſtrumentally we can hardly obſerue 5 minuts: therefore be

our tables be drawne to anſwere to our inſtrumentall obſeruations.

5 If the arke of the leſſer quadrant excéed 45 degrées, you ſhall find the ſame in the table vpon the right ſide the page, at the lower end of the ſaid table, the minutes anſwering whereunto, doe aſcend in the laſt columne vpon the right hand.

6 So that if the giuen arke be vnder 45, find the deg. and min. in the table vpon the left hand, if aboue 45, in the table vpon the right hand.

7 The complement of any arke in the leſſer quadrant, ſtands directly againſt the ark giuen, but not in the ſame table; as the arke giuen is 3 deg. 45 min. thoſe deg. and min. are found in the table vpon the left hand, anſwering to which in the table vpon the right hand, in the laſt row, is 86 degrées, 15 minutes, the complement of 3 deg. 45 min. or if 86 & 85 min. had bene the giuen arke, 3 deg. and 45 min. in the other table was the complement to the ſame.

8 Briefly, this table extends but to the halfe arke of the leſſer quadrant, yet doth ſerue to the whole arke in the greater or leſſer quadrant, as in the 10 def. conſect. 1, ſo that you may find any arke or angle giuen, together with the ſines, Tangents and ſecants anſwering therunto; alſo the complements of the arkes or of the ſines &c. or the ſine, Tangent or ſecant being giuen, you may find the arke anſwering thereunto.

The giuen arke is 3 degrées 35 minutes.		The complement of the arke 86 deg. 25 min. whoſe.	
Sine	6250	Sine	99804
Tangent.	6262	Tangent (is)	1596867
Secant	100195	Secant	1599995

9 If the ſine &c. be giuen, and the arke required, ſéeke in the body of the tables for the ſine, and then remembring the precedent rules, the arke anſwereth thereunto.

10 Touching arkes in the greater quadrant, they and the complements thereof ſtand in the tables vpon the right hand with the minutes anſwering: they begin at 90 deg. in the firſt row at the toppe of the right tables, and ſo procéed to 135, and then goe forward in the foote of the table, being the lowermoſt of the two numbers placed there; but if you ſéeke the complement of thoſe numbers in the other table on the left hand, in

the foote of the tables, they be in the table on the left hand, as if you ſéeke the complement of 176 deg. 25 min. the degrées of complement is in the table vpon the left hand, and in the row vnder it is the minute alſo, as 3 deg. 35 min. which makes 176 deg. 25 min. iuſt 180 deg.

11 There is no Tangent or Secant in the greater quadrant by the 15 and 16 Def.

12 So that if you ſéeke the complement of any arke in the greater quadrant, if the degrées and minutes ſtand in the firſt row in the right table vpon the left hand, then the complement thereof is the vppermoſt of the numbers in the foote of the ſayd table vpon the right margent, and the minutes ſtand in the vttermoſt columne rightwards aſcending.

13 But if you ſéeke the complement of any of the numbers that ſtand lowermoſt in the foote of the right table, then muſt the degrées of complement be ſought in the left table.

14 Subtract the arch giuen from 90, the remainder is Sinus Complementi of the leſſer quadrant.

15 Subtract Sinus Complementi of the arch giuen from the totall ſine, the remainder is Sinus verſus, as Sinus Complementi is 35027, which take from 100000, and there remaines 64973. Sinus verſus is in ſtead of the right ſine of any arke of the greater quadrant, the complement thereof is vſed: therefore the arke it ſelfe doth ſerue in theſe tables, becauſe the true arke ſtands againſt the complement, as well in the great quadrant as in the leſſer, as is ſayd.

16 Deduct the arke giuen from 180, the remainder is Sinus Complementi of the greater quadrant.

A Canon

A Canon or Table for the dimenſion of Triangles compendiouſly calculated. 1609.

Belonging to the 7 booke of the Geodedical ſtaffe called Trigonometria.

0	Sines	Tang	Secants	90	Sines	Tang.	Secants.	M
1			100000	1	10000	Infinite	Infinite	60
5	145	145	100000	5	99999	68754887	98754060	55
10	290	290	100000	10	99999	34377371	34377516	50
15	436	436	100000	15	99999	22918166	22918384	45
20	581	581	100001	20	99998	17188540	17188831	40
25	727	727	100002	25	99997	13750735	13751108	35
30	872	872	100003	30	99996	11458865	11459301	30
35	1018	1018	100005	35	99994	9821794	9822303	25
40	1163	1163	100006	40	99993	8593979	8594561	20
45	1308	1309	100008	45	99991	7639001	7639055	15
50	1454	1454	100010	50	99989	6875909	6875736	10
55	1599	1599	100012	55	99987	6249915	6250715	5
60	1745	1745	100013	60	99984	5729869	5728996	0

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Canon Triangulorum.

1	Sines	Tang	Secants	91	Sines	Tang.	Secants	M
5	1890	1891	100017	5	99928	5288211	5289156	55
10	2036	2036	100020	10	99978	4841208	4911406	50
15	2181	2182	100023	15	99976	4582935	4584026	45
20	2326	2327	100027	20	99972	4296408	4297571	40
25	2472	2473	100030	25	99969	4043584	4044820	35
30	2617	2618	100034	30	99965	3818846	3820155	30
35	2763	2764	100039	35	99961	3617760	3619141	25
40	2908	2909	100042	40	99957	3436777	3438232	20
45	3053	3055	100046	45	99953	3273026	3274554	15
50	3199	3200	100051	50	99948	3124158	3125758	10
55	3344	3346	100055	55	99944	2988230	2989903	5
60	3489	3492	100060	60	99939	2863625	2865371	0

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Canon Triangulorum.

2	Sines	Tang.	Secants	92	Sines	Tang.	Secants	M	
5	3635	3637	100066	5	99933	2748985	2750804	55	
10	3780	3783	100071	10	99928	2643160	2645051	50	
15	3925	3929	100077	15	99922	2545170	2547130	45	
20	4074	4074	100082	20	99917	2454176	2456212	40	
25	4216	4220	100089	25	99911	2369454	2371563	35	
30	4362	4366	100095	30	99904	2290377	2292559	30	
35	4507	4511	100101	35	99898	2216398	2218653	25	
40	4652	4657	100108	40	99891	2147040	2149368	20	
45	4797	4893	100115	45	99884	2081883	2084283	15	
50	4943	4949	100122	50	99877	2020555	2023028	10	
55	5088	5094	100129	55	99870	1962730	1965275	5	
60	5233	5240	100137	60	99862	1908114	1910733	0	87

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Canon Triangulorum.

3	Sines	Tang.	Secants	93	Sines	Tang.	Secants	M	
5	5378	5386	100144	5	99855	1856447	1859139	55	
10	5524	5532	100152	10	99847	1807498	1810262	50	
15	5669	5678	100161	15	99839	1761056	1763893	45	
20	5814	5824	100169	20	99830	1716934	1719843	40	
25	5959	5970	100178	25	99822	1674961	1677944	35	
30	6104	6116	100186	30	99813	1634986	1638044	30	
35	6250	6262	100195	35	99804	1596867	1599995	25	
40	6395	6408	100205	40	99795	1560478	1563679	20	
45	6540	6554	100214	45	99785	1525705	1528979	15	
50	6685	6700	100224	50	99776	1492442	1495788	10	
50	6830	6846	100234	55	99766	1460592	1464011	5	
60	6975	6992	100244	60	99756	1430067	1433559	0	86

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Canon Triangulorum.

4	Sines	Tang.	Secants	94	Sines	Tang.	Secants	M	
5	7120	7138	100254	5	99746	1400786	1494350	55	
10	7265	7285	100265	10	99735	1372674	1376311	50	
15	7410	7431	100275	15	99725	1345663	1349373	45	
20	7555	7577	100286	20	99714	1319688	1323472	40	
25	7700	7723	100297	25	99703	1294692	1298549	35	
30	7845	7870	100309	30	99691	1270620	1274549	30	
35	7990	8016	100321	35	99680	1247422	1251424	25	
40	8135	8162	100332	40	99688	1225051	1229125	20	
45	8280	8309	100344	45	99656	1203462	1207610	15	
50	8425	8455	100356	50	99644	1182617	1186837	10	
55	8570	8602	100369	55	99632	1162476	1166769	5	
60	8715	8748	100381	60	99619	1143005	1147371	0	85

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Canon Triangulorum.

5	Sines	Tang.	Secants	95	Sines	Tang.	Secants	M	
5	8860	8895	100394	5	99606	1124171	1128610	55	
10	9005	9042	100407	10	99593	1105943	1110454	50	
15	9150	9188	100421	15	99580	1088292	1092876	45	
20	9294	9335	100434	20	99567	1071191	1075848	40	
25	9439	9482	100448	25	99553	1054615	1059345	35	
30	9584	9628	100462	30	99539	1038539	1043343	30	
35	9729	9775	100476	35	99525	1022942	1027818	25	
40	9874	9922	100491	40	99511	1007803	1012752	20	
45	10018	10069	100525	45	99496	993100	998122	15	
50	10163	10216	100523	50	99482	978817	983912	10	
55	10308	10363	100535	55	99467	964934	970102	5	
60	10452	10510	200550	60	99452	951436	956677	0	84

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Canon Triangulorum.

6	Sines	Tang.	Secants	96	Sines	Tang.	Secants	M
5	10597	10657	100566	5	99433	938306	943620	55
10	10742	10804	100582	10	99421	925530	930916	50
15	10886	10951	100597	15	99405	913093	918553	45
20	11031	11098	100614	20	99389	900982	906515	40
25	11175	11246	100630	25	99373	889185	894790	35
30	11320	11393	100646	30	99357	877688	883367	30
35	11464	11540	100663	35	99340	866482	872233	25
40	11609	11688	100680	40	99323	855554	861379	20
45	11753	11835	100697	45	99306	844895	850793	15
50	11898	11983	100715	50	99289	834495	840465	10
55	12042	12130	100733	55	99272	824344	830388	5
60	12168	12278	100750	60	99254	814434	820550	0

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Canon Triangulorum.

7	Sines	Tang.	Secants	97	Sines	Tang.	Secants	M
5	12331	12426	100769	5	99236	804756	810945	55
10	12475	12573	100787	10	99218	795302	801564	50
15	12619	12721	100805	15	99200	786064	792399	45
20	12764	12869	100824	20	99182	777035	783443	40
25	12908	13017	100843	25	99163	768207	774689	35
30	13052	13165	100862	30	99144	759575	766129	30
35	13196	13313	100882	35	99125	751131	757759	25
40	13340	13461	100901	40	99106	742870	749571	20
45	13485	13609	100921	45	99086	734786	741559	15
50	13629	13757	100941	50	99066	726872	733719	10
55	13773	13905	100962	55	99046	719124	726044	5
60	13917	14054	100982	60	99026	711536	718529	0

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Canon Triangulorum.

8	Sines.	Tang.	Secants	98	Sines.	Tangẽts	Secants		
5	14061	14202	101009	5	99006	704104	711170	55	
10	24205	14350	101024	10	98985	696823	703962	50	
15	24349	14499	101045	15	98965	689687	696899	45	
20	14493	14647	101067	20	98944	682694	689979	40	
25	14637	14796	101088	25	98922	675838	683196	35	
30	14780	14945	101110	30	98901	669115	676546	30	
35	14924	15093	101132	35	98879	662522	670026	25	
40	15068	15242	101155	40	98858	656055	663632	20	
45	15212	15391	101177	45	98836	649710	657361	15	
50	15356	15540	101200	50	98813	643484	651208	10	
55	15499	15689	101223	55	98791	637373	645170	5	
60	15643	15838	101246	60	18768	631375	639245	0	81

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Canon Triangulorum.

9	Sines.	Tang.	Secants	99	Sines.	Tangent	Secants		
5	15787	15987	101269	5	98745	625485	633429	55	
10	15930	16136	101293	10	98722	619702	627719	50	
15	16074	16286	101317	15	98699	614023	622112	45	
20	16217	19435	101341	20	98676	608443	616606	40	
25	16361	16584	101365	25	98652	602962	611198	35	
30	16504	16734	101390	30	98628	597576	605885	30	
35	16648	16883	101415	35	98604	592283	600665	25	
40	16791	17033	101440	40	98580	587080	595536	20	
45	16934	17183	101465	45	98555	581965	590494	15	
50	17078	17332	101491	50	98530	576936	585539	10	
55	17221	17482	101516	55	98505	571991	580667	5	
60	17364	17632	101542	60	98480	567128	575877	0	80

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Canon Trangulorum.

10	Sines.	Tang.	Secants.	100	Sines.	Tangẽts	Secants.	M
5	17508	17782	101568	5	98455	562344	521166	55
10	17651	17932	101595	10	98429	557637	566533	50
15	17794	18082	101621	15	98404	553007	561971	45
20	17937	18233	101648	20	98478	548450	557491	40
25	18080	18383	101675	25	98351	543966	553081	35
30	18223	18533	101703	30	98325	539551	548740	30
35	18366	18684	101730	35	98298	535206	544468	25
40	18509	18834	101758	40	98272	530927	540263	20
45	18652	18985	101786	45	98245	526715	536123	15
50	18791	19136	101814	50	98217	522566	532048	10
55	18938	19287	101842	55	98190	518480	528035	5
60	19080	19438	101871	60	98162	514455	524084	0

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Canon Triangulorum.

11	Sines.	Tang.	Secantes.	101	Sines.	Tangẽts	Secants.	M
5	19223	19589	101900	5	98134	510490	520192	55
10	19366	19740	101929	10	98106	506583	516359	50
15	19509	19891	101959	15	98078	509733	512583	45
20	19651	20042	101988	20	98050	498940	508862	40
25	19794	20183	102018	25	88021	495201	505197	35
30	19936	20345	102048	30	97992	491515	501585	30
35	20079	20496	102078	35	97963	487882	498025	25
40	20221	20648	102109	40	97934	484300	494516	20
45	20364	20800	102140	45	97904	480764	491058	15
50	20506	20951	102171	50	97874	477285	487649	10
55	20648	21103	102202	55	97844	473850	484287	5
60	20791	21255	102234	60	97814	470463	480937	0

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Canon Triangulorum.

12	Sines.	Tang.	Secants	102	Sines.	Tangẽt	Secants		
5	20933	21407	102265	5	97784	467121	477705	55	
10	21075	21559	102279	10	97753	463825	474482	50	
15	21217	21712	102329	15	97723	460572	471303	45	
20	21359	22864	102362	20	97692	457362	468167	40	
25	21501	22016	102395	25	97660	454196	465074	35	
30	21643	22169	102427	30	97629	451070	462022	30	
35	21785	22322	102461	35	97598	447986	459011	25	
40	21927	22474	102494	40	97566	444941	456040	20	
45	22069	22627	102528	45	97534	441936	453109	15	
50	22211	22780	102561	50	97502	438969	450215	10	
55	22353	22933	102596	55	97469	436040	447359	5	
60	22495	23086	102630	60	17437	433147	444541	0	77

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Canon Triangulorum.

13	Sines.	Tang.	Secants	103	Sines	Tangent	Secants		
5	22636	23240	102664	5	97404	430291	441758	55	
10	22778	23393	102699	10	97371	427470	439011	50	
15	22920	23546	102734	15	97337	424684	436299	45	
20	23061	23700	102770	20	97364	421933	433621	40	
25	23203	23854	102805	25	97270	419215	430977	35	
30	23344	23007	102841	30	97236	416529	428365	30	
35	23485	24161	102877	35	97202	413877	425786	25	
40	23627	24315	102913	40	97168	411256	423239	20	
45	23768	24469	102950	45	97134	408666	420723	15	
50	23909	24624	102587	50	97099	406107	418237	10	
55	24051	24778	103024	55	97064	403577	415782	5	
60	24192	24932	103061	60	97029	401078	413356	0	76

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Canon Triangulorum.

14	Sines.	Tang.	Secants	104	Sines.	Tangẽts	Secants.	M	
5	24333	25087	103098	5	96994	398607	410959	55	
10	24474	25242	103136	10	96958	396165	408591	50	
15	24615	25396	103174	15	96923	393750	406250	45	
20	24756	25551	103212	20	96887	391364	403938	40	
25	24897	25706	103251	25	96851	389004	401652	35	
30	25038	25861	103290	30	96814	386671	399392	30	
35	25178	26016	103329	35	96778	384364	397159	25	
40	25319	26172	103368	40	96741	382082	394952	20	
45	25460	26327	103407	45	96704	379826	392769	15	
50	25600	26483	103447	50	96667	377595	390612	10	
55	25741	26639	103487	55	96630	375388	388479	5	
60	25881	26794	103527	60	96592	373205	386370	0	75

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Canon Triangulorum.

15	Sines.	Tang.	Secants	105	Sines.	Tangẽts	Secants.	M	
5	26022	26950	103568	5	96554	371945	384284	55	
10	26162	27106	103608	10	96516	368909	382222	50	
15	26303	27263	103649	15	96478	366795	380183	45	
20	26443	27419	103691	20	96440	364704	378165	40	
25	26583	27575	103732	25	96401	362635	376171	35	
30	26723	27732	103774	30	96363	360588	374197	30	
35	27863	27889	108816	35	96324	358562	372245	25	
40	27004	28045	103858	40	96284	356557	370315	20	
45	27144	28202	103900	45	96245	354573	368404	15	
50	27284	28359	103943	50	96245	352629	366515	10	
55	27451	28517	103986	55	96166	356065	364645	5	
60	27563	28674	104029	60	96126	348741	362795	0	74

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Canon Triangulorum.

16	Sines	Tang.	Secants	106	Sines	Tang.	Secants	M.
5	27703	28832	104073	5	96085	346836	360965	55
10	27843	28989	104117	10	96045	344951	359153	50
15	27982	29147	104161	15	96004	343084	357361	45
20	28122	29305	104205	20	95964	341236	355587	40
25	28262	29463	104250	25	95923	339406	353831	35
30	28401	29621	104294	30	95881	337594	352093	30
35	28542	29779	104339	35	95840	335800	350373	25
40	28680	29938	104385	40	95798	334023	348671	20
45	28819	30096	104430	45	95757	332263	346985	15
50	28958	30255	104476	50	95715	330520	345317	10
55	29098	30414	104522	55	95672	328794	343665	5
60	29237	30573	104569	60	95630	327085	342030	0

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Canon Triangulorum.

17	Sines	Tang.	Secants	107	Sines	Tang.	Secants	M.
5	29376	30732	104615	5	95587	325391	340411	55
10	29515	30891	104662	10	95545	323714	338808	50
15	29654	31050	104709	15	95501	322052	337220	45
20	29793	31210	104757	20	95458	320406	335649	40
25	29931	31370	104804	25	95415	318775	334092	35
30	30070	31529	104852	30	95371	317159	332550	30
35	30209	31689	104901	35	95327	315558	331024	25
40	30347	31849	104949	40	95283	313971	329512	20
45	30486	32010	104998	45	95239	312399	328014	15
50	30624	32170	105047	50	95195	310842	326531	10
55	30763	32331	105096	55	95150	309298	325062	5
60	30901	32492	105146	60	95105	307768	323606	0

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Canon Triangulorum.

18	Sines.	Tang.	Secants
5	31039	32652	105196
10	31178	32813	105246
15	31316	32975	105296
20	31454	33136	105347
25	31592	33297	105398
30	31730	33459	105449
35	31868	33621	105500
40	32006	33783	105552
45	22143	33945	105604
50	32281	34107	105656
55	32419	34270	105709
60	42556	34432	105762

108	Sines.	Tangẽts	Secants.	M
5	95060	306252	322165	55
10	95015	304749	320786	50
15	94969	303259	319321	45
20	94924	301789	317919	40
25	94878	300319	316530	35
30	94832	398868	315154	30
35	94786	297430	313790	25
40	94739	296004	312439	20
45	94693	294590	311100	15
50	94646	293188	309773	10
55	94599	291799	308458	5
60	94551	290421	307155	0

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Canon Triangulorum.

19	Sines.	Tang.	Secants.
5	32694	34595	105815
10	32831	34758	105868
15	32969	34922	105922
20	33106	35084	105976
25	33243	35248	106030
30	33380	35411	106084
35	33517	35575	106139
40	33654	35739	106194
45	33791	35903	106250
50	33928	36067	106350
55	34065	36232	106361
60	34202	36397	106417

109	Sines.	Tangẽts	Secants.	M
5	94504	289054	305863	55
10	94456	287699	304583	50
15	94408	286356	303314	45
20	94360	285023	302056	40
25	94312	283701	30081	35
30	94264	282391	299574	30
35	94215	281091	298349	25
40	94166	279801	297134	20
45	94117	278523	295930	15
50	94068	277254	294737	10
55	94018	275996	293553	5
60	93969	274747	292308	0

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Canon Triangulorum.

20	Sines.	Tang.	Secants	110	Sines.	Tangẽts	Secants	M	
5	34338	36561	106474	5	93919	273509	291217	55	
10	34475	36726	106531	10	93869	272280	290063	50	
15	34612	36891	107588	15	93819	271061	288919	45	
20	34748	37057	106645	20	93768	269852	287785	40	
25	34884	37222	106705	25	93718	268652	286660	35	
30	35020	37388	106760	30	93667	267462	285545	30	
35	35156	37554	106819	35	93616	266280	284438	25	
40	35293	37720	106877	40	93564	265108	283341	20	
45	35429	37886	106936	45	93513	263945	282253	15	
50	35565	38053	106995	50	93461	262791	281174	10	
55	35700	38219	107054	55	93410	261645	280104	5	
60	35836	38386	107114	60	93358	260508	279042	0	69

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Canon Triangulorum.

21	Sines.	Tang.	Secants	111	Sines	Tangent	Secants	M	
5	35972	38553	107174	5	93305	259380	277989	55	
10	36108	38720	107234	10	93253	258266	276945	50	
15	36243	38887	107295	15	93200	257149	275909	45	
20	36379	39055	107356	20	93147	256046	274881	40	
25	36514	39223	107417	25	93094	254951	273861	35	
30	36650	39391	107478	30	93041	253864	272850	30	
35	36785	39559	107540	35	92988	252785	271846	25	
40	36920	39727	107602	40	92934	251715	270851	20	
45	37055	39895	107664	45	92880	250651	269863	15	
50	37190	40064	107727	50	92826	249596	268883	10	
55	37325	40233	107790	55	92772	248548	267911	5	
60	37460	40402	107853	60	92718	247508	266946	0	68

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Canon Triangulorum.

22	Sines	Tang.	Secants	112	Sines	Tang.	Secants.	M
5	37595	40571	107917	5	92668	246475	265989	55
10	37730	40741	107980	10	92609	245450	265039	50
15	37864	40911	108044	15	92554	244432	264097	45
20	37999	41080	108109	20	92498	243421	263161	40
25	38133	41251	108174	25	92443	242418	262233	35
30	38268	41421	108239	30	92387	241421	261312	30
35	38402	41591	108304	35	92332	240431	260398	25
40	38536	41762	108370	40	92276	239448	259491	20
45	38671	41933	108436	45	92220	238472	258591	15
50	28805	42104	108502	50	92163	237503	257697	10
55	38919	42275	108569	55	92107	236541	256810	5
60	39073	42447	108636	60	92050	235585	255930	0

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Canon Triangulorum.

23	Sines	Tang.	Secants	113	Sines	Tang.	Secants	M
5	39206	42619	108703	5	91993	234635	255056	55
10	39340	22791	108770	10	91936	233692	254189	50
15	39474	42963	108838	15	91879	232756	253328	45
20	39607	43135	108906	20	91821	231826	252474	40
25	39741	43308	108975	25	91763	230902	251626	35
30	39874	43481	109044	30	91706	229984	250784	30
35	40008	43654	109113	35	91647	229072	249948	25
40	40141	43827	109182	40	91589	228166	249118	20
45	40274	44001	109252	45	91531	227267	248295	15
50	40407	44174	109322	50	91472	226373	247477	10
55	40540	44348	109392	55	91413	225485	246665	5
60	40673	44522	109463	60	91354	224603	245859	0

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Canon Triangulorum.

24	Sines.	Tang.	Secants	114	Sines.	Tangẽts	Secants	M	
5	40806	44697	109534	5	91295	223727	245059	55	
10	40939	44871	109606	10	91235	222856	244264	50	
15	41071	45046	109677	15	91176	221991	243475	45	
20	41204	45221	109749	20	91116	221132	242692	40	
25	41336	45397	109822	25	91056	220278	241914	35	
30	41469	45572	109894	30	90996	219429	241142	30	
35	41601	45748	109967	35	90935	218586	240375	25	
40	41733	45924	110041	40	90875	217749	239613	20	
45	41865	46100	110114	45	90814	216916	238857	15	
50	41998	46277	110188	50	90753	216089	238106	10	
55	42129	46453	110263	55	90692	215267	237360	5	
60	42261	46630	110337	60	90630	214459	236620	0	65

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Canon Triangulorum.

25	Sines.	Tang.	Secants	115	Sines	Tangent	Secants	M	
5	42393	46807	110412	5	90569	213638	235884	55	
10	42525	46985	110488	10	90507	212832	235154	50	
15	42656	47163	110563	15	90445	212030	234428	45	
20	42788	47340	110639	20	90383	211233	233708	40	
25	42919	47519	110716	25	90321	210441	23299	35	
30	43051	47697	110792	30	90258	209654	23228	30	
35	43182	47876	110869	35	90195	208872	231576	25	
40	43313	48055	110947	40	90132	208094	230875	20	
45	43444	48234	111024	45	90069	207321	230178	15	
50	43575	48413	111103	50	90006	206553	229486	10	
55	43706	48593	111181	55	89943	205789	228799	5	
60	43837	48773	111260	60	89879	205030	228117	0	64

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Canon Triangulorum.

26	Sines	Tang.	Secants	116	Sines	Tang.	Secants.	M	
5	43967	48953	111339	5	89815	204275	227439	55	
10	44098	49133	111418	10	89751	203525	226765	50	
15	44228	49314	111498	15	89687	292779	226096	45	
20	44359	49495	111578	20	89622	202038	225432	40	
25	44489	49676	111659	25	89558	201301	224771	35	
30	44619	49858	111740	30	87493	200568	224115	30	
35	44749	50039	111821	35	89428	199840	223464	25	
40	44879	50221	111902	40	89363	199116	222816	20	
45	45009	50404	111984	45	89297	198396	222173	15	
50	45139	50586	112066	50	89232	197680	221534	10	
55	45269	50769	112149	55	89166	196968	220899	5	
60	45399	50952	112232	60	89100	196261	220268	0	63

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Canon Triangulorum.

27	Sines	Tang.	Secants	117	Sines	Tang.	Secants	M	
5	45528	51135	112315	5	89034	195557	219642	55	
10	45658	51319	112399	10	88968	194857	219019	50	
15	45787	51503	112483	15	88901	194162	218400	45	
20	45916	51687	112568	20	88835	193470	217785	40	
25	46045	51871	112653	25	88768	192782	217175	35	
30	46174	52056	112738	30	88701	192098	216568	30	
35	46303	52241	112823	35	88633	191417	215964	25	
40	46432	52426	112909	40	88566	190741	215365	20	
45	46571	52612	112995	45	88498	190068	214769	15	
50	46690	52798	113082	50	88430	189399	214178	10	
55	46818	52984	113169	55	88362	188734	213589	5	
60	46947	52170	113257	60	88294	188072	213005	0	62

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Canon Triangulorum.

28	Sines	Tang.	Secants	118	Sines	Tang.	Secants	M	
5	47075	53357	113344	5	88226	187414	212424	55	
10	47203	53544	113432	10	88157	186760	211847	50	
15	47331	53731	113521	15	88089	186109	211273	45	
20	47460	53919	113610	20	88020	185461	210703	40	
25	47588	54107	113699	25	87951	184817	210136	35	
30	47715	54295	113789	30	87881	184177	209573	30	
35	47843	54484	113879	35	87812	183539	209014	25	
40	47971	54672	113969	40	87742	182906	208457	20	
45	48098	54861	114060	45	87602	182275	207905	15	
50	48226	55051	114151	50	87602	181648	207555	10	
55	48353	55240	114243	55	87532	181025	206809	5	
60	48480	55430	114335	60	87461	180404	206266	0	61

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Canon Triangulorum.

29	Sines	Tang.	Secants	119	Sines	Tang.	Secants	M	
5	48608	55621	114427	5	87391	179787	205726	55	
10	48735	55811	114520	10	87320	179173	205190	50	
15	48862	56002	114613	15	87245	178562	204657	45	
20	48988	56193	114707	20	87178	177955	204127	40	
25	49115	56385	114801	25	87107	177350	203600	35	
30	49242	56577	114895	30	87035	176749	204077	30	
35	49368	56769	114990	35	86963	176151	202556	25	
40	49495	56961	115085	40	86891	175555	202039	20	
45	49621	57154	115180	45	86819	174963	201524	15	
50	49747	57347	115276	50	86747	174374	201013	10	
55	49873	57541	115373	55	86675	173788	200505	5	
60	50000	57735	115450	60	86602	173205	200000	0	60

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Canon Triangulorum.

30	Sines	Tang.	Secants	120	Sines	Tang.	Secants	M
5	50125	57929	115567	5	86529	172624	199497	55
10	50251	58123	115664	10	86456	172047	198998	50
15	50377	58318	115762	15	86383	171472	198501	45
20	50502	58513	115861	20	86310	170901	198008	40
25	50628	58708	115959	25	86236	170332	197517	35
30	50753	58904	116059	30	86162	169767	197029	30
35	50879	59100	116158	35	86089	169203	196544	25
40	51004	59296	116258	40	86014	168642	196062	20
45	51129	59493	116359	45	85940	168084	195582	15
50	51254	59690	116460	50	85868	167529	195105	10
55	51379	59888	116561	55	85791	166977	194631	5
60	51503	60086	116663	60	85716	166427	194160	0

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Canon Triangulorum.

31	Sines	Tang.	Secants	121	Sines	Tang.	Secants.	M
5	51628	60284	116765	5	85641	165880	193691	55
10	51725	60482	116868	10	85566	165336	193225	50
15	51877	60681	116971	15	85491	164794	192762	45
20	52001	60880	117074	20	85415	164255	192301	40
25	52125	61086	117178	25	85339	163719	191843	35
30	52249	61280	117282	30	85264	163185	191388	30
35	52373	61480	117387	35	85187	162653	190935	25
40	52497	61680	117492	40	85111	162124	190484	20
45	52621	61881	117598	45	85035	161598	190036	15
50	52745	62083	117704	50	84958	161074	189591	10
55	52868	62284	117810	55	84881	160552	189148	5
60	52991	62486	117917	60	84804	160033	188707	0

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Canon Triangulorum.

32	Sines	Tang.	Secants	122	Sines	Tang.	Secants	M
5	53115	62689	118025	5	84727	159516	188269	55
10	53238	62892	118133	10	84650	159002	187834	50
15	53361	63095	118241	15	84572	158490	187401	45
20	53484	63298	118350	20	84495	157980	186970	40
25	53607	63502	118459	25	84417	157473	186541	35
30	53729	63707	118568	30	84339	156968	186115	30
35	53852	63911	118679	35	84260	156465	185692	25
40	53975	64116	118789	40	84182	155965	185270	20
45	54097	64322	118900	45	84103	155467	184851	15
50	54219	64527	119012	50	84025	154971	184434	10
55	54341	64734	119123	55	83946	154477	184020	5
60	54463	64940	119236	60	83867	153986	183607	0

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Canon Triangulorum.

33	Sines	Tang.	Secants	123	Sines	Tang.	Secants	M
5	54585	65147	119549	5	83787	153497	183197	55
10	54707	65355	119462	10	83708	153010	182789	50
15	54829	65562	119576	15	83628	152525	182384	45
20	54050	65771	119690	20	83548	152042	181980	40
25	55072	65979	119805	25	83468	151562	181579	35
30	55191	66188	119920	30	83388	151083	181180	30
35	55314	66397	120036	35	83308	150607	180783	25
40	55436	66607	120152	40	83227	150132	180388	20
45	55557	66817	120268	45	83146	149660	179995	15
50	55677	67028	120386	50	83066	149190	179604	10
55	55798	67239	120503	55	82985	148722	179215	5
60	55919	67450	120621	60	82903	148256	178829	0

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Canon Triangulorum.

34	Sines.	Tang.	Secants	124	Sines.	Tangēts	Secants.	M.
5	56039	67662	120740	5	82822	147791	178444	55
10	56160	67878	120859	10	82740	147329	178062	50
15	56280	68087	120979	15	82658	146869	177681	45
20	56400	68300	121099	20	82577	146411	177302	40
25	56520	68514	121219	25	82494	145955	176926	35
30	56640	68728	121329	30	82412	145500	176551	30
35	56760	68942	121461	35	82330	145948	176179	25
40	56880	99157	121584	40	82247	144598	175808	20
45	56999	69372	121706	45	82164	144149	175439	15
50	57119	99588	121829	50	82081	143702	175072	10
55	57238	69805	121953	55	81998	143257	174707	5
60	57357	70020	122077	60	81915	142814	174344	0

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Canon Triangulorum.

35	Sines.	Tang.	Seqants	125	Sines.	Tangēts	Secants.	M.
5	57476	70237	122202	5	81831	142373	173983	55
10	57595	70455	122327	10	81748	141934	173624	50
15	57714	70673	122452	15	81664	141496	173266	45
20	57833	70891	122578	20	81580	141060	172910	40
25	57951	71110	122705	25	81495	140627	172557	35
30	58070	71329	122832	30	81411	140194	172205	30
35	58188	71548	122960	35	81327	139764	171854	25
40	58306	71769	123088	40	81242	139335	271506	20
45	59424	71989	123217	45	81157	138908	171159	15
50	58542	72210	123346	50	81070	138483	170814	10
55	58660	72432	123476	55	80987	138060	170471	5
60	58778	72654	123606	60	80901	137638	170130	0

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Canon Triangulorum.

36	Sines	Tang.	Secantes	126	Sines	Tang.	Secants	M	
5	58896	72876	123737	5	80826	137218	169790	55	
10	59013	73099	123869	10	80730	136799	169452	50	
15	59130	73323	124001	15	80644	136382	169116	45	
20	59248	73546	124133	20	80558	135967	168782	40	
25	59365	73771	124266	25	80472	135554	168448	35	
30	59482	73996	124400	30	80385	135142	168117	30	
35	59599	74221	124534	35	80299	134731	167787	25	
40	59715	74447	124669	40	80212	134323	167459	20	
45	59832	74673	124804	45	80125	133916	167123	15	
50	59948	74900	124940	50	80038	133510	166808	10	
55	60065	75127	125076	55	79952	133106	166485	5	
60	60181	75355	125213	60	79863	132704	166164	0	52

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Canon Triangulorum.

37	Sines	Tang.	Secantes	127	Sines	Tang.	Secants	M	
5	60274	75583	125351	5	78711	132303	165844	55	
10	60413	75812	125489	10	79688	131904	165462	50	
15	60529	76041	125627	15	79600	131506	165208	45	
20	60645	76271	125767	20	79512	131110	164893	40	
25	60760	76501	125906	25	79423	130715	164580	35	
30	60876	76632	126047	30	79335	130322	164267	30	
35	60991	76964	126188	35	79246	129930	163957	25	
40	61106	77195	126329	40	79157	129540	163648	20	
45	61221	77428	126461	45	79068	129151	163340	15	
50	61336	77614	126614	50	78979	128764	163034	10	
55	61451	77894	126757	55	78890	128378	162730	5	
60	61566	78128	126901	60	78801	127994	162426	0	52

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Canon Triangulorum.

38	Sines.	Tang.	Secants	128	Sines.	Tangẽts	Secants.	M
5	61680	78363	127046	5	78711	127611	162125	55
10	61795	758 12	127191	10	78621	127229	161825	50
15	61909	78833	127337	15	78531	126849	161526	45
20	62023	79069	127483	20	78441	126470	161229	40
25	62137	79306	127630	25	78351	126093	160933	35
30	62251	79543	127777	30	78260	125717	160638	30
35	62365	79781	127926	35	78170	125342	160345	25
40	62478	80019	128074	40	78079	124969	160054	20
45	62592	80258	128224	45	77988	124597	159763	15
50	62705	80497	128374	50	77898	124226	159475	10
55	62818	80737	128524	55	77806	123857	159187	5
60	62932	80978	128676	60	77714	123489	158901	0

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Canon Triangulorum.

39	Sines.	Tang.	Secants	129	Sines.	Tangẽts	Secants.	M
5	63045	81219	128827	5	77622	123123	158617	55
10	63157	81461	128980	10	77521	122757	158333	50
15	63270	81703	129133	15	77439	122393	158051	45
20	63383	81946	129287	20	77347	122031	157770	40
25	63495	82189	129441	25	77254	121669	157491	35
30	63607	82433	129596	30	77762	121309	157213	30
35	63719	82678	129752	35	77669	120950	156936	25
40	63832	82972	129908	40	76977	120593	156661	20
45	63943	83169	130065	45	76884	120236	156397	15
50	64055	83415	130223	50	76791	119881	156114	10
55	64167	83662	130381	55	76697	119527	155842	5
60	64278	83909	130540	60	76604	119175	155572	0

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Canon Triangulorum.

40	Sines.	Tang.	Secants
5	64390	84158	130700
10	64501	84406	130860
15	64612	84656	131021
20	64723	84906	131183
25	64834	85156	131345
30	64944	85408	131508
35	65055	85659	131672
40	65165	85912	131836
45	65275	86165	132001
50	65386	86419	132167
55	65496	86673	132334
60	65605	86928	132501

130	Sines.	Tangẽts	Secants	M
5	76510	118823	155303	55
10	76417	118473	155035	50
15	76323	118124	154769	45
20	76229	117777	154503	40
25	76134	117430	154239	35
30	76049	117084	153976	30
35	75946	116740	153715	25
40	75851	116397	153454	20
45	75756	116055	153195	15
50	75661	115714	152937	10
55	75506	115375	152680	5
60	75470	115036	152425	0

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Canon Triangulorum.

41	Sines.	Tang.	Secants
5	65715	87184	132669
10	65815	87440	132837
15	65934	87697	133007
20	66043	87955	133177
25	66153	88213	133347
30	66262	88473	133519
35	66370	88730	133691
40	66479	88992	133864
45	66588	89253	134037
50	66696	89567	134212
55	66804	89777	134387
60	66913	90040	134563

131	Sines	Tang.	Secants	M
5	75375	114699	152170	55
10	75279	114363	151917	50
15	75183	114028	151665	45
20	75088	113694	151414	40
25	74991	113361	151164	35
30	74895	113029	150916	30
35	74799	112698	150668	25
40	74702	112369	150422	20
45	74605	112040	150176	15
50	74508	111713	149932	10
55	74411	111386	149689	5
60	74314	111061	149447	0

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Canon Triangulorum.

42	Sines	Tang.	Secants	132	Sines	Tang.	Secants	M
5	67021	90304	134739	5	74217	110736	149206	55
10	67128	90568	134917	10	74119	110413	148967	50
15	67239	90833	135095	15	74021	110091	148728	45
20	67344	91099	135274	20	73923	109770	148490	40
25	67451	91365	135453	25	73825	109450	148234	35
30	67559	91633	135634	30	73727	109130	148018	30
35	67666	91901	135815	35	73629	108812	147784	25
40	67773	92169	135997	40	73530	108495	147550	20
45	67880	92439	136179	45	73432	108179	147318	15
50	67986	92709	136363	50	73333	107864	147087	10
55	68093	92979	136547	55	73214	107550	146857	5
60	68199	93251	136732	60	73135	107236	146667	0

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Canon Triangulorum.

43	Sines	Tang.	Secants	133	Sines	Tang.	Secants.	M
5	68306	93523	136918	5	73036	106924	146399	55
10	68412	93796	137105	10	72936	106613	146217	50
15	68518	94070	137292	15	72837	106303	145946	45
20	68624	94345	137480	20	72737	105992	145721	40
25	68729	94620	137669	25	72637	105685	145497	35
30	68835	94896	137859	30	72537	105378	145273	30
35	68940	95173	138050	35	72437	105071	145051	25
40	69046	95450	138242	40	72336	104765	144830	20
45	69151	95729	138434	45	72236	104461	144610	15
50	69256	96008	138627	50	72135	104157	144391	10
55	69361	96288	138821	55	72034	103854	144172	5
60	69465	96568	139016	60	71933.	103553.	143955	0

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Canon

Canon Triangulorum.

44	Sines.	Tang.	Secants
5	69570	96850	139212
10	69674	97132	139408
15	69790	97415	139605
20	69883	97699	139884
25	69987	97984	140003
30	70090	98269	140203
35	70194	98556	140404
40	70298	98843	140605
45	70401	99131	140808
50	70504	99419	141011
55	70607	99709	141216
60	70710	10000	147427

134	Sines.	Tangẽts	Secants	M
5	71832	103252	143739	55
10	71731	102952	143523	50
15	71630	102652	143309	45
20	71528	102354	143095	40
25	71426	102057	142883	35
30	71325	101760	142671	30
35	71223	101465	142461	25
40	71120	101170	141251	20
45	71018	100876	142047	15
50	70916	100583	141814	10
55	70813	100291	141621	5
60	70710	100000	141421	0

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I might here take occaſion to teach you to worke matters Aſtronomicall, but it was not my intent ſo to do in this volume, ſuch that deſire the ſame, may finde ſome ſatiſfaction therein, wrote by Maſter Blundeuill, & who ſo deſireth it more ample, moſt alſo in ſuch matters haue more ample tables, for theſe tables be onely drawne to be applied to inſtrumentall obſeruation as I haue ſaid before, wherein we may find the iuſt minute, as preciſely as can be obſerued inſtrumentally, and what needeth more?

# THE EIGHTH BOOKE
Of the Geodeticall Staffe;

Whereby is performed moſt concluſions that may be wrought by the Globe or any Aſtrolabe, with the art of Horomancie, wherein you be taught to make Horizontall, Verticall, and Eaſt and Weſt Dials, with diuerſe others only by the Staffe, without any kind of Arithmeticke; to draw a Map of the world, according to the Longitude and Latitude of the places; to find how one place doth beare from another, by the poynts of the Mariners Compaſſe and ſuch like: in all which you ſhall craue but the onely helpe of your ſtaffe.

CHAP. I.
Principall notes and definitions for the better vnderſtanding of this booke.

FIRST, this kind of worke conſiſteth in proiecting yͤ celeſtial circles in to parallell and Ellipticall lines.

2 According vnto perſpectiue demonſtrations, there can but the halfe of any ſpheare be layd downe in plano.

3 Def. All parallel lines be circles of latitude, declination, and circles of altitude and depreſſion.

4 Def. Lines Ellipticall be meridians, Azimuths and circles of longitude.

5 Def. All circles of latitude be parallell to the Eclipticke in all Aſtronomicall operations, and are meaſured by Chords vpon the lymbe.

6 Def. All circles of declination lye parallell vnto the Equinoctiall, and are expreſſed by chords.

7 Def. Circles of altitude and depreſſion lye parallell to the horizon, and are expreſſed as other parallels be.

8 Def. Circles of declination be counted upon the limbe from the equinoctiall towards the poles.

9 Def. Circles of latitude are counted from the Zodiacke upon the limbe.

10 Def. Circles of altitude and depreſſion are counted from the Horizon on the limbe.

11 Def. Take it generall that all parallell lines are counted on the limbe from that great circle they lye parallell unto, towards the pole thereof.

Lines Ellipſicall.

12 Def. You muſt firſt underſtand, that all kind of ellipticall lines by a certaine reducement are meaſured by chords upon the limbe, like to parallels.

13 Def. A meridian is a great circle paſſing by the poles of the world, and cutting the equinoctiall at right angles, expreſſed by chords, and reduced to the limbe by lines parallell to the 6 of clocke meridian.

14 Def. All Azimuths be great circles paſſing by the verticall point, and croſſing the horizon at right angles, expreſſed by chords on the limbe, and transferred thereunto by lines parallell to the eaſt and weſt Azimuth.

15 All circles of longitude be great circles paſſing by the poles of the Zodiack, cutting the eclipticke at right angles, meaſured upon the limbe and transferred thereunto by lines parallell unto the axis of the eclipticke.

16 Def. All great circles be meridians, circles of longitude, verticall circles, Colures, the equinoctiall, ecliptike, &c.

17 Def. All leſſe circles be parallels.

18 Def. Generally all great circles croſſe one the other upon the center, and all other leſſe circles never croſſe over the center.

19 The center in this projectment doth repreſent the equinoctiall points of ♈ & ♎, the circumference, the meridian, or 12 of clocke line; but in ſome concluſions, the Solſtitiall Colure.

20 Def. All times are reckoned from 12 of the clocke at noone, to 12 at night, and are meaſured in the parallell of the ſunne (and ſo do Aſtronomers count it in their Ephemerides) and counted from the axes of the Equinoctiall.

21 Def. One degrée of the Equinoctiall containes foure minutes of time, and 15 degrées one houre, for which purpoſe behold the inſuing table.

A Table

A Table of reduction of the parts of time into the parts of the Equinoctiall arke.						A Table of reduction of the parts of the Equator circle into parts of the like time.					
parts of houres.	the arke of the equinoc. circle.		parts of houres.	the arke of the equator.		the arke of the equinoc. circle.	parts of time.		the arke of the equator	parts of time.	
min.	gra.	mi.	min.	gra.	mi.	gra.	ho.	mi.	gra.	ho.	min.
1	0	15	31	7	45	1	0	4	31	2	4
2	0	30	32	8	0	2	0	8	32	2	8
3	0	45	33	8	15	3	0	12	33	2	12
4	1	0	34	8	30	4	0	16	34	2	16
5	1	15	35	8	45	5	0	20	35	2	20
6	1	30	36	9	0	6	0	24	36	2	24
7	1	45	37	9	15	7	0	28	37	2	28
8	2	0	38	9	30	8	0	32	38	2	32
9	2	15	39	9	45	9	0	36	39	2	36
10	2	30	40	10	0	10	0	40	49	2	40
11	2	45	41	10	15	11	0	44	41	2	44
12	3	0	42	10	30	12	0	48	42	2	48
13	3	15	43	10	45	13	0	52	43	2	52
14	3	30	44	11	0	14	0	56	44	2	56
15	3	45	45	11	15	15	1	0	45	3	0
16	4	0	46	11	30	16	1	4	46	3	4
17	4	15	47	11	45	17	1	8	47	3	8
18	4	30	48	12	0	18	1	12	48	3	12
19	4	45	49	12	15	19	1	16	49	3	16
20	5	0	50	12	30	20	1	20	50	3	20
21	5	15	51	12	45	21	1	24	51	3	24
22	5	30	52	13	0	22	1	28	52	3	28
23	5	45	53	13	15	23	1	32	53	3	32
24	6	0	54	13	30	24	1	36	54	3	36
25	6	15	55	13	45	25	1	40	55	3	40
26	6	30	56	14	0	26	1	44	56	3	44
27	6	45	57	14	15	27	1	48	67	3	48
28	7	0	58	14	30	28	1	52	58	3	52
29	7	15	59	14	45	29	1	56	59	3	56
30	7	30	60	15	0	30	2	0	60	4	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Chap. II.

To expreſſe any chord in the limbe of a circle, and to protract any angle.

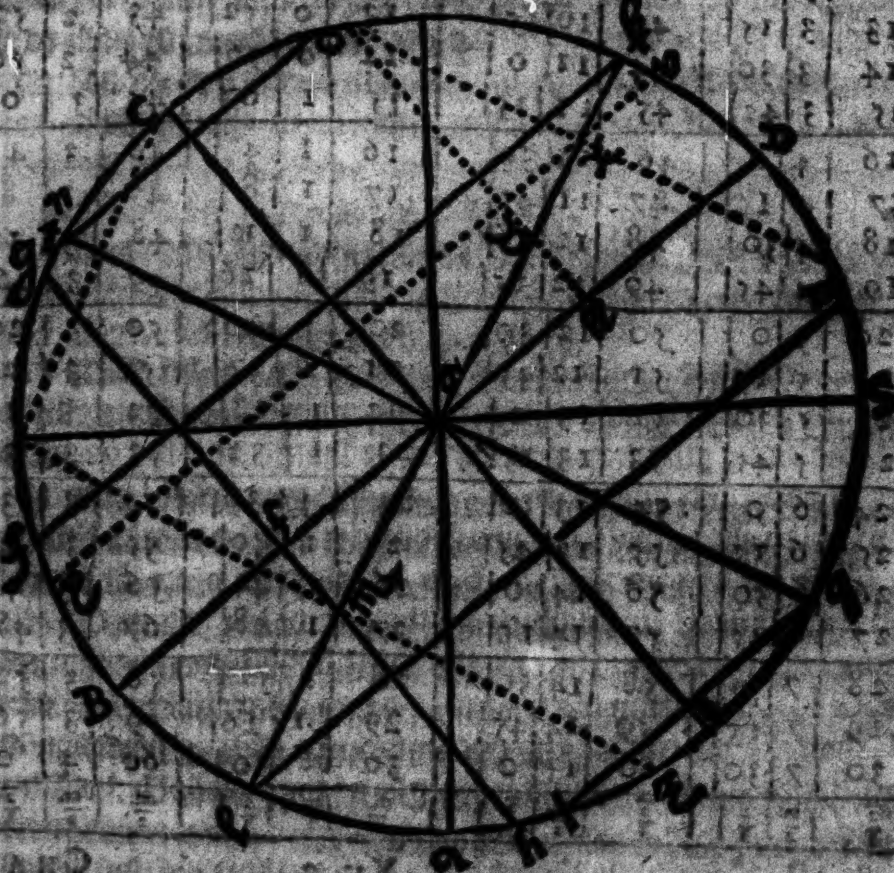
THis Chapter, and the other fiue enſuing, well vnderſtood, the reſt of the booke is but eaſy.

To meaſure any thing in a circumference is no other thing but either hauing a chord giuẽ to expreſſe the quantity thereof, or hauing an angle giuen to protract the like: for which purpoſe the 2 Chapter of the 6 booke ſhall very fully inſtruct you in all points, therefore I will referre you thereunto for breuities ſake.

Chap III.

Any parte of a diameter being giuen or required, to expreſſe the ſame in degrees.

TO meaſure a diameter, is either for to expreſſe the parte giuen, or to giue the part expreſſed.



Any diameter in this worke is a great circle, by the 17 def. becauſe he croſſeth the center; then to expreſſe the part giuen, worke thus.

Let A B C D E be an hemiſphere, and let the propoſition be to expreſſe A F part of the diameter B D, by the 2 def. this muſt be transferred to the circumference, thus: draw a line G H, to paſſe by the pointe F parallel to C E, then by the firſt Chap. meaſure G C or H E, ſo haue you your deſire.

2 To giue the part expreſſed is, when there is any number of degrées expreſſed, to find the pointe whereon they fall, performed thus.

I haue a number of degrées giuen as 30, and am required to ſhew in what part of the diameter A D, they end.

By the firſt Chapter, I protract a chord G C of 30 degrées, from whence I draw a line G H parallel to C D, & where that point cuts the diameter A B as at F, there is your deſire; I conclude that A F containes 30 degrées

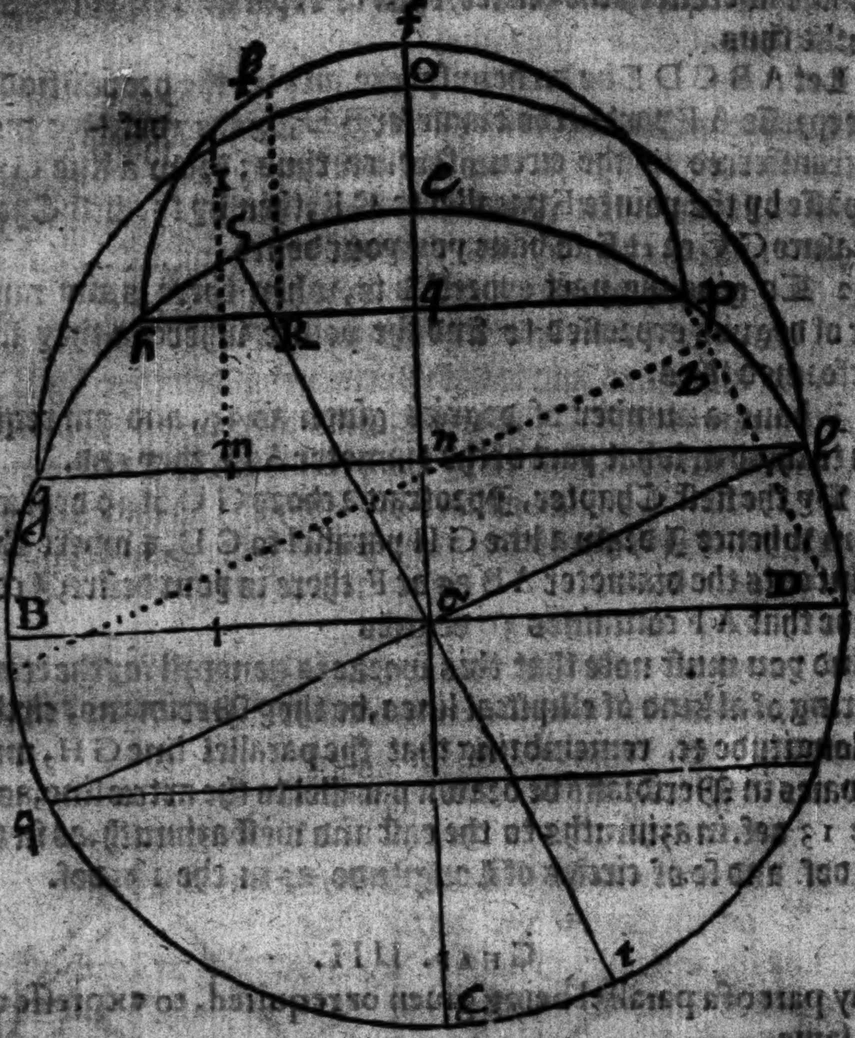
And you muſt note that this worke is generall for the transferring of al kind of ellipticall lines, be they Meridians, circles of longitude &c. remembring that the parallel line G H, muſt alwaies in Meridians be drawn parallel to the axtrée line, as in the 13 def. in azimuths to the eaſt and weſt azimuth, as in the 14 def. and ſo of circles of Longitude, as in the 15 def.

Chap. IIII.

Any part of a parallel being giuen or required, to expreſſe the ſame.

To meaſure a parallel, is either to find what Ellipticall line paſſeth by ſome point in any parallel, or ſome ellipticall line being giuen, to find where he ſhould cut the parallel: and to do either, you muſt firſt make the parallel the diameter of a circle, whereupon deſcribe a ſemicircle, then worke thus. Firſt, let the parallel be G L, and let the prop. be to find what Ellipticall line paſſeth by the pointe M, make G L the diameter of a circle, then on the point N deſcribe the ſemicircle, G I L, next from that point M draw a parallel to F A as I M, then the portion of the circumference I O, is your deſire, 30 degrées, by the 1 Chapter, and ſo of the parallel H P or any other.

2 But if you haue the number of the ellipticall line giuen,



and be required to find what pointe of the parallel he should passe by, worke thus.

Let the parallel be H P, and let the proposition be to find where the 30 Ellipticall line shall passe by?

Make H P the diameter of a circle, and then upon Q the center describe H F P the semicircle, then by the first Chap. protract a chord F K 30 degrees, whence draw a line parallel to F A as K R, which shall cut the parallel H P in R, I conclude that R is the point where as yͤ 30 ellipticall line should passe by, and so of G L, or any other parallel.

Chap. V.

Any point being giuen in the hemiſphere, to find what Ellipſicall line paſſeth by the ſame.

The premiſſes well underſtood, this Chapter is eaſy. The point being aſſigned, you ſhal conſider whether your queſtion be to know what Meridian, what circle of longitude or Azimuth paſſeth there by, and then calling to minde the end of the third Chapter, worke thus.

Let the point taken in the hemiſpere A B C D E be R, and let the queſtion be to find what Meridian paſſeth thereby, B D is the Equinoctiall, E C the axtree, draw therefore by the point R a line parallel to B D; then by the 4 Chapter, firſt difference, find what Ellipſicall line paſſeth by R, which you ſhall find 30. I conclude, the 30 Meridian doth paſſe by the point P, and ſo of any other.

The figure in the 4 Chapter ſerueth here.

Chap. VI.

To draw a paralell by any number of degrees aſſigned, or a parallel being drawne, to find what number of degrees he containes.

What parallel circles be, is ſhewed in the firſt Chap. which conſidered, worke thus.

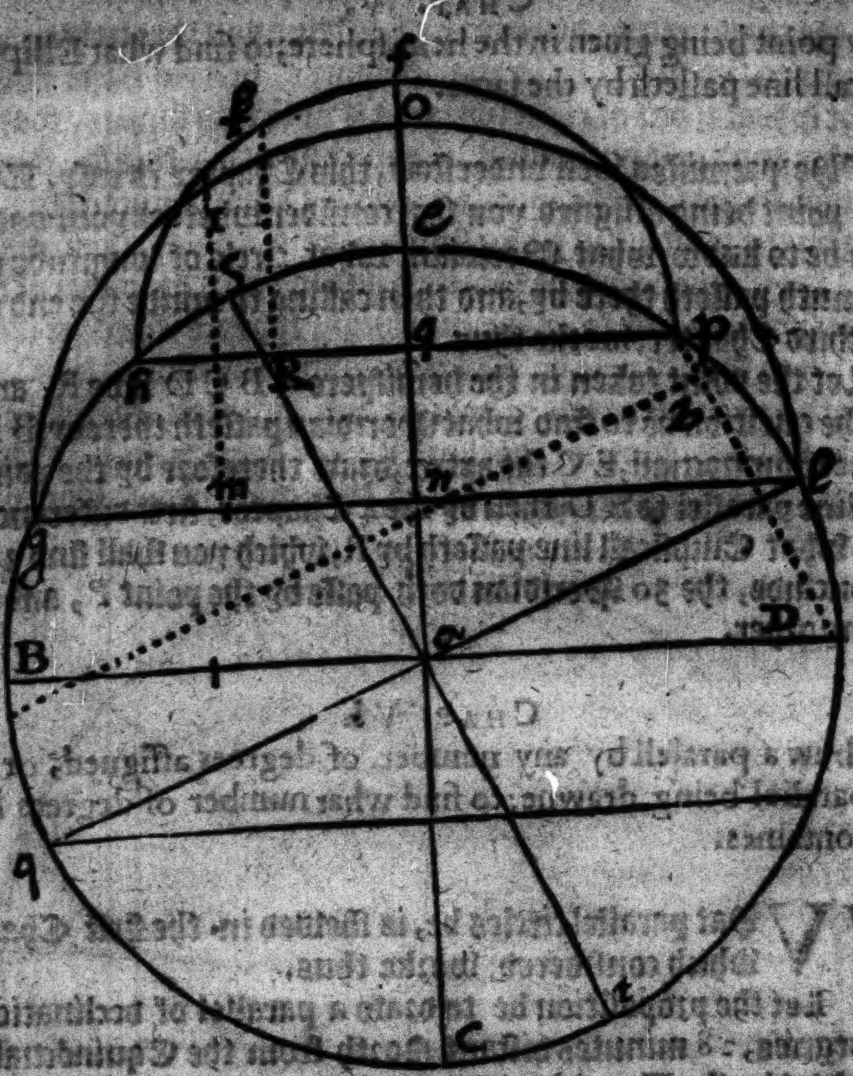
1 Let the propoſition be to draw a parallel of declination 23 degrées, 28 minutes diſtant North from the Equinoctiall, which let be the Tropick of Cancer.

Let A B C D E be the hemiſpere, B D the Equinoctiall, F C the axtree, then by the firſt Chapter I protract a chorde B G, and L D 23 degrées, 28 minutes, from the equinoctiall: I then conclude that G L is the parallel repreſenting the Tropick of Cancer, and ſo of any other.

2 But if a parallel be drawne, and you would find what number of degrées it containes, doe thus.

Let the parallell be H P, then by the firſt Chapter, find the chord B H 50 degrées, your demand by the 50 deg.

Chap.



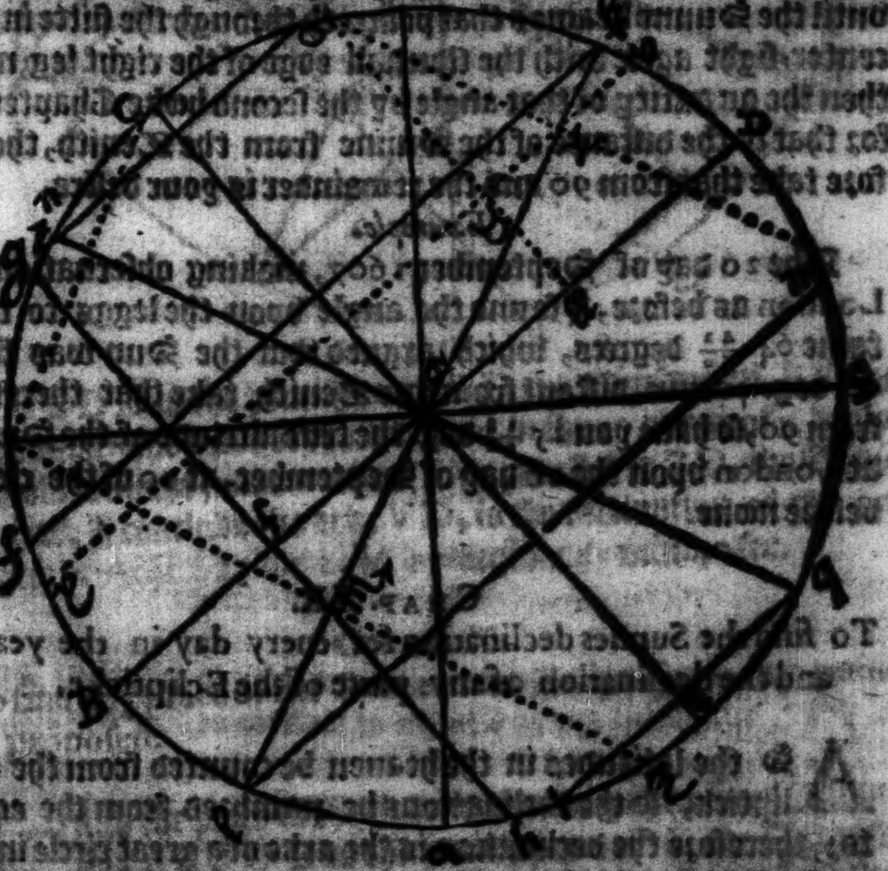
Chap. VII.

To lay downe a right oblique ſpheare.

An oblique ſpheare is ſuch an one, whoſe North or South pole is eleuated any thing at all aboue the Horizon, and is thus laide downe.

Let A B C D E be the hemiſpheare, then drawe the diameter B D which call the Equinoctiall, then croſſe B D with a right line vpon the center A at right angles as C E, which call the axtree of the world, C the North pole, E the South, then drawe a parallel to B D the Equinoctiall 23 degrees, 28 toward the North pole A, by the laſt Chap. which let be F K, call that the Tropick of Cancer, doe ſo vpon the other ſide the Equinoctiall as L M, call that the Tropick of Capricorne, next drawe N O

D, 23 degrees, 28 minutes, from C, and parallel to B D, which call the circle articke, and ſo to B D, ſo haue you the circle antartick: then the line L K is the Equinoctiall, ſo haue you a right ſpheare; but of right ſpheares I note two kindes, that is a polar and an Equinoctiall, if you will make this an Equinoctiall, make C E the Horizon, and B D the Equinoctiall paſſing by the zenith; but if you will make it a polar, then make B D the Equinoctiall the Horizon, and ſo you haue the [illegible] right ſpheare; but to make the oblique ſpheare, conſider if the North or South pole be elevated, and how much, let C the North pole be elevated 52 degrees and [illegible] minutes, [illegible] by the firſt Chapter, [illegible] the chord R G 52 degrees and [illegible] [illegible] in the circumference, ſo haue you



the line R S the Horizon O, being [illegible] 52 degrees [illegible] this circle is generall, and then the poles of the Horizon viz. the Zenith and Nadir be T V, and the poles of the Ecliptick L K be N Q, for the poles of the Ecliptick [illegible] the circles, Articke and Antarticke, [illegible] then the [illegible] 12 of clocke line to the Horologe.

Now ſhall follow ſome Conclusions Aſtronomicall, which will be very eaſie if you vnderſtand what is ſaid before, for all the workes doth conſiſt thereupon.

Chap. VIII.

To take the altitude of the Sunne.

I haue taught you how to performe this [illegible] in my ſecond booke, howbeit I ſhall not being it [illegible] here to deliuer an other way no leſſe eaſie, and [illegible] for [illegible]: [illegible] therefore the left legge to hang perpendicular, the [illegible] (which you may [illegible]) as by your [illegible] plumbe at the [illegible] the legges frontwards the Sun, heauing vp or putting down ÿ right leg vntill the Sunne beames that pearceth through the ſlitte in the center-ſight agree with the fiduciall edge of the right leg, note then the quantity of that angle by the ſecond booke Chapter 5, for that is the diſtance of the Sunne from the Zenith, therefore take that from 90 and the remainder is your deſire.

Example.

The 20 day of September 1607, making obſeruation at London as before, I found the angle vpon the leggs to containe 64 $\frac{42}{60}$ degrees, which argued that the Sun was then 64 deg. 42 min. diſtant from our Zenith; take that therefore from 90, ſo haue you 25 $\frac{18}{60}$ deg. the true altitude of the Sunne at London vpon the 20 day of September, at 10 of the clocke before none.

Chap. IX.

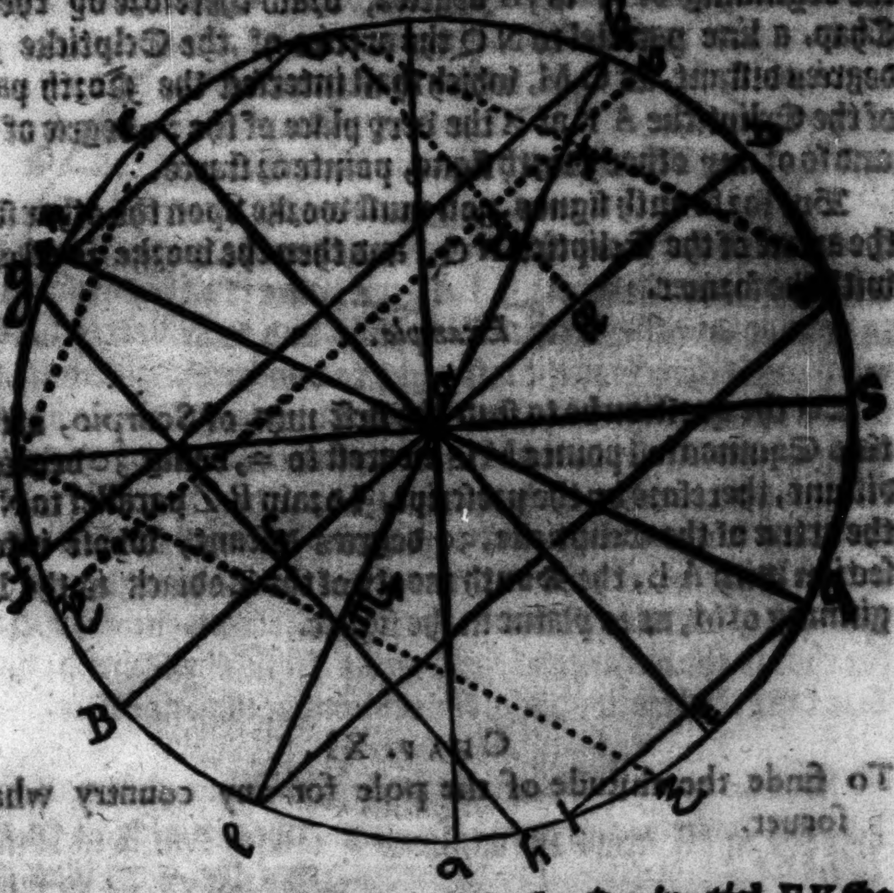
To find the Sunnes declination for euery day in the yeare, and the declination of any parte of the Eclipticke.

As the latitudes in the heauen be counted from the Ecliptick, ſo the declinations be numbred from the equator, therefore the declination is the arke of a great circle intercepted betwixt the Equator and the place of Eclipticke or ſtar. Thus [illegible]:

H. By the [illegible] find the place of the Sunne in the Ecliptick, by which point imagine a parallel to the Equinoctiall, then the chord on the periphery betwixt that parallel & the Equinoctiall is your deſire.

Example.

The figure in the third Chapter serueth here.



BCDE is the hemispheare, B D the Equinoctiall, F K the Ecliptick ♉ the place of the Sunne, viz. in the 20 degree of ♉, draw therefore by the point ♉ a line Y V, parallel to B D, the Equinoctiall; I conclude the arke V D, is the declination of the 20 degree of ♉ which by the 2, is 17 degrees 43 min. 40 sec.

Chap. X.

To find any place of the Sunne in the Eclipticke, or any point proposed.

To find the place of the Sunn in the Eclipticke, worke thus. Let A B C D E be the hemispheare, F K the Tropick of ♋, K L the Ecliptick, and let the prop. be to find where the 20 degree of ♉ falleth.

In this worke you be to consider, how many degrees the Sunne is distant from the next Equinoctiall point of ♈ or ♎ which can neuer exceed 90 degrees, and thereby whether the question be for North or South ſignes, as here it falleth out for or by the 20 degree of ♉ a North ſigne, whoſe diſtance from the beginning of ♈ is 50 degrees, draw therefore by the 6 Chap. a line parallel to N Q the axtree of the Eclipticke 50 degrees diſtant, as O M, which ſhall interſect the North part of the Eclipticke A K at X the very place of the 20 degree of ♉, and ſo of any other North ſigne, pointe or ſtarre.

The figure in the third Chapter ſerveth here.

But for South ſignes, you muſt worke upon the other ſide the axtree of the Eclipticke N Q, and then the worke is all one with the former.

Example.

Let the queſtion be to find the firſt min. of Scorpio, of the two Equinoctiall points M is neareſt to ♎, being 30 degrees diſtant, therefore by the preceipt, I draw R Z parallel to N Q the axtree of the Eclipticke, 30 degrees diſtant, whoſe interſection with A L, the South moity of the Zodiack is the beginning of M, as is plaine in the figure.

Chap. XI.

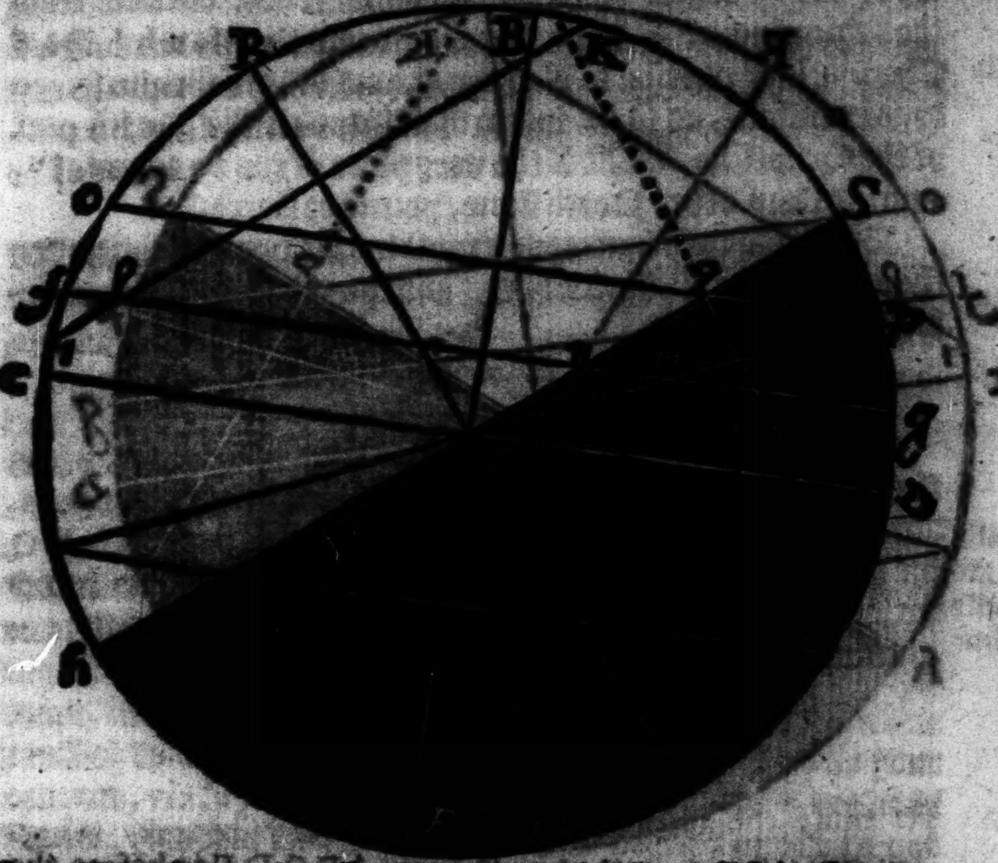
To finde the altitude of the pole for any country whatſoever.

The altitude or elevation of the pole is a portion of a Meridian included betwixt the Horizon, & the pole elevated, had thus:

Lay downe a right ſpheare as if his poles were in the Zenith by the 7, then by the 6. draw a parallel according to the Sunnes declination, Next having the Meridian altitude of the Sunne draw a line by the 6, diſtant from the parallel of the Sunne, according to the Meridians altitude, by the end of which numbers draw a line croſſing the center, whoſe diſtance on the peripher from the pole, is your deſire.

Example.

Let the hemiſpheare be A B C D E, then I draw a parallel according to the declination of the Sunne, the 10 of April, 11 $\frac{4}{5}$ degrees, then I count the Meridian Altitude of the Sunne 50 degrees, from F towards E, as to H, then did I draw a line



from H to A, and ſo to I: I conclude the chord BI is the elevation 51 $\frac{40}{55}$ by the 2 Chap.

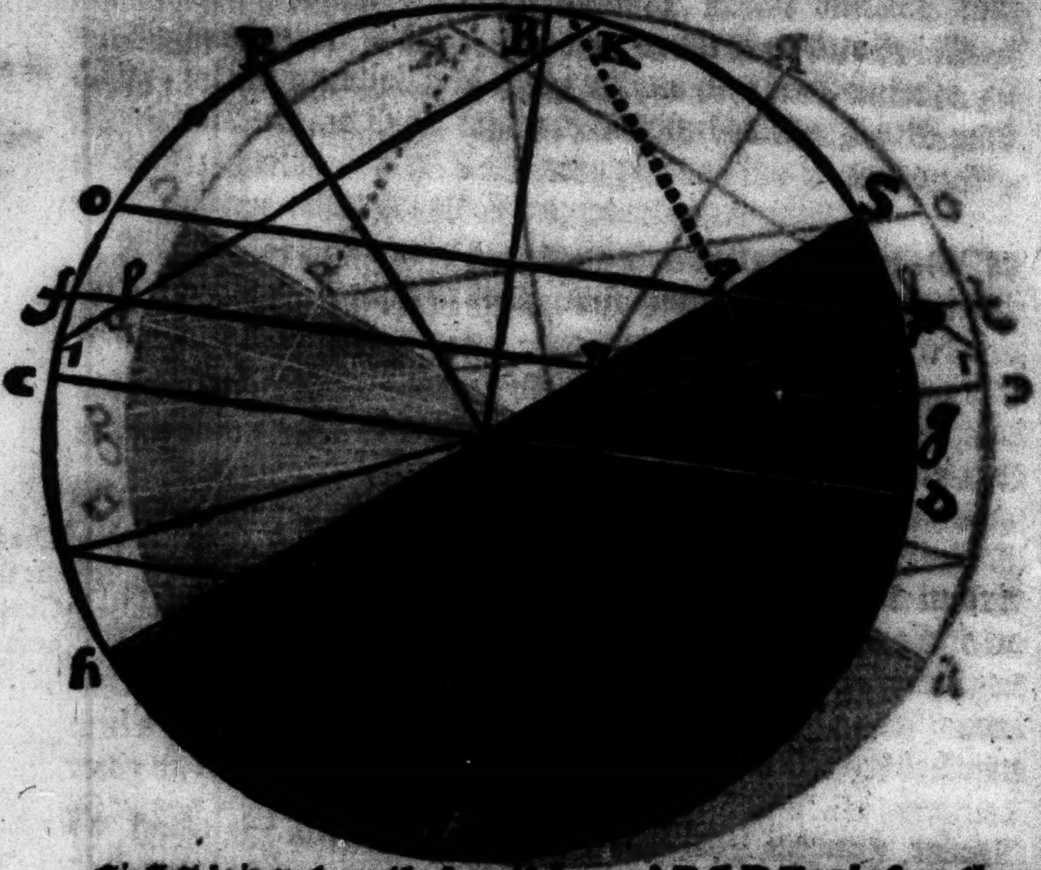
CHAP. XII.

To know what howre of the day it is, the Sunne ſhining in any Region.

TO know what of the clocke it is, is to finde how many 15 degrees the Sunne is diſtant on his parallel from the Meridian, and ſo many howers, is the time of the day lacking or paſt the common 12 of clocke, according as the queſtion, fell before or after noone.

Lay therefore downe a ſphære according to the elevation of your pole, and draw a parallel by the 6 according unto the declination of the Sunne then take the altitude of the Sun, and by the 7 and 10 def. of the firſt Chapter, draw an almicanter according to the altitude taken. Laſtly, the Meridian by the 4 Chapter, paſſing by the interſection of the almicanter and parallel of declination, is your deſire.

Upon the 10 of April I made obſervation as followeth;



Firſt I laid downe the hemiſphere A B C D E as before, then I drawe F G a parallel by the 6, according vnto the Sunnes declination $11\frac{40}{60}$ degrées, next by the 8, I obſerued the altitude of the Sunne $40\frac{12}{60}$ degrées, and by the 6 according to the 7 and 10 def. Chap. 1, I drawe an almicanter I K according to the Sunnes altitude taken, which interſects with F G the parallel of declination at L. Laſtly I found by the 5 that the 30 Meridian paſſed by L, reckoned from F, then for that my obſeruation was before noone, I may ſafely conclude that it was preciſely 10 of the clocke, for that 30 degrées containes two houres, as is plaine in the table in the firſt chap. If my obſeruation had bene after noone, it had bene iuſt two of the clocke, then the Azimuth cut in there, ſheweth the coaſt: and if you know not whether your obſeruation were before or after noone after your firſt taking the Sunnes altitude, anon after obſerue it againe, if then the altitude be greater then it was before, then were your obſeruations before noone, if leſſe, after noone.

To find the right aſcention of any portion of the Ecliptick, or together with the degrees of the Equinoctiall, that doe aſcend with every degree of the Ecliptick in a right Spheare.

The right aſcention is a portion or arke of the Equator that riſeth with any given arke of the Ecliptick, or any point or ſtarre in a right Spheare, and found thus.

Lay downe a right ſpheare, ſo that the poles may be in the horizon, then let a right Meridian paſſe by that point to the Equinoctiall, ſo have you your deſire.

Example.

The figure in the third Chapter ſerveth here.

Let ABCDE be a planiſphere, BD the Equinoctiall, LK the Ecliptick, & let the propoſition be to finde the right aſcention of the 0 degree of ♉, by the 0 Chapter finde the place of the 0 deg. of ♉ in the Ecliptick A L, which is marked with his character, and by that point in the Ecliptick draw thereby a line parallel to C E as O L L: I conclude the arke O C is your demand, viz. 27 54/60 deg. the right aſcention of the 0 degree of Taurus, and this rule is generall for all degrees or points not above 90 deg. diſtant from ♈, which is three ſignes full.

But you muſt note that ÿ point given, may either containe full 90 degrees, which is three ſignes, or be more then 90, and yet leſſe then 180, or more then 180, and yet leſſe then 270 or more then 270, and leſſe then 360.

1 If the arke be full 90 deg. containing 3 ſignes as the 0 degree of ♋, then is 90 the right aſcention.

2 If the arke be more then 90 as the 0 degree of ♌ 120, and leſſe then 180, then ſubſtract the arke given from 180 viz. 120 from 180, ſo have you 60 remaining, then take the right aſcention of the remainder (as of 60) as before: 60 containes 2 ſignes, therefore I take the right aſcention of 0 deg. ♊, which is 2 ſignes from ♈, which I find 57 48/60 deg. which take from 180, the remainder is the right aſcention of the given arke, viz. 57 deg. 48 min. taken from 180, ſo have you 122 12/60 degr. and ſo have you done.

3 But if the arke comprehended betwixt ♈ and the point given, be more then 180, and yet leſſe then 270, that is, if the arke be more then 6 ſignes and leſſe then 9, as the 0 deg. of ♏ 210 degrees or 7 ſignes, ſubſtract 180 degrees from that arke

the right aſcention of the remainder taken from the beginning of ♎ and adde to 180, ſo haue you your deſire, as for the purpoſe 180 taken from 210 leaueth 30, which containeth one ſigne, whoſe right aſcention by the former is 27 deg. 54 min. 20 ſec. which added to 180, maketh 207 deg. 54 min. 20 ſec. the right aſcention of the 0 deg. of ♏.

4 Laſtly, if the arke giuen, comprehended betwixt Aries and the point aſſigned be greater then 270 or 9 ſignes, as the 0 deg. of ♒ 300 deg. or 10 ſignes, then ſubſtract that arke from 360, than the right aſcention of the remainder taken from 360 leaueth your deſire, as 300 taken from 360 leaueth 60, or two ſignes, whoſe right aſcention 57 deg. 48 min. 48 ſec. taken from 360 leaueth 302 deg. 11 min. 12 ſec. the right aſcention of 0 deg. of Aquarius ſo that you ſee by finding the right aſcention of any arke vnder 90 deg. as you be taught to doe, you haue the right aſcention of any other arke.

And I would haue you note, that oppoſite ſignes, and ſignes alike diſtant from the Equinoctiall point, doe aſcend in a right ſpheare in equall time, as ♈ ♎ and ♓ ♍, ſo doth alſo ♉ ♏ ♒ ♌ and in like manner Gem. Can. Cap. Sagit.

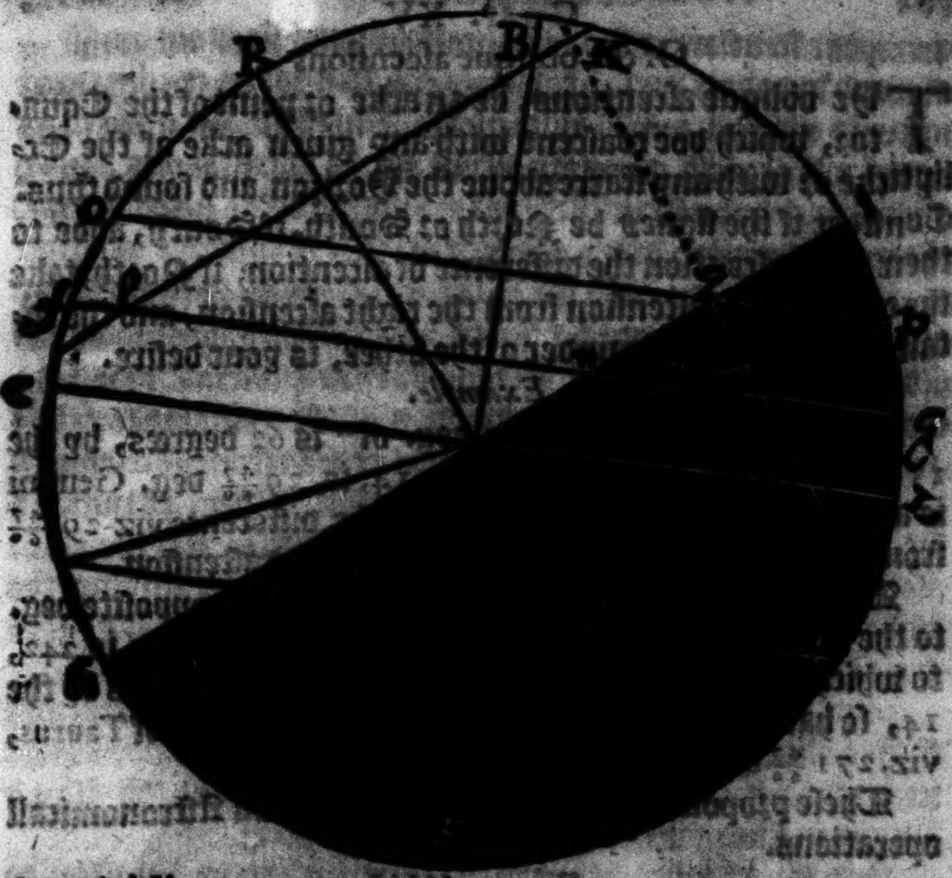
And for as much as euery Meridian is a right Horizon to ſome one place or other, therefore the degree of the Eclipticke conſcending with any deg. of the Equinoctiall, in a right ſpheare muſt of neceſſity paſſe by the Meridian of any place together, and this is called the culminating of a Starre, or culmination, ſo that you may gather hereby that the culminating of any point in the heauens is all one in ſubſtance with his right aſcention.

CHAP. XIIII.

Of the difference of aſcentions.

The difference of aſcention is an arke of the Equator whereby the oblique aſcention or deſcention of the Ecliptick doth differ from the right.

Now to finde the difference of aſcentions, hauing laid downe a ſpheare according vnto your Latitude, ſet in the Eclipticke line, the deg. whoſe aſcentionall difference you ſeeke, by which point draw a line parallell to the Equinoctiall, then note the interſection of that parallel with the Horizon, for the Meridian paſſing by that point is your deſire, being reckoned from the



the arctick line.

Example.

Let A B C D E be an hemiſpheare, let the propoſition be to find the aſcentionall difference of the 29 degree of ♉, let M be the 26 of ♉, by which draw F G parallel to C D the Equinoctiall, let the Horizon be I H B, the pole elevated 52 degrees $\frac{30}{60}$ then I note the interſection of F G with I H, as at N. Laſtly by the fourth I ſeeke what Meridian paſſeth by N reckoned from B E, which I find 12 $\frac{46}{60}$ Meridian and better. I then conclude that the aſcentionall difference of the 26 degree of ♉ in the 52 $\frac{30}{60}$ degree of latitude, is 13 degrees, 16 min. 26 ſec. ſo that Taurus, becauſe he is a ſigne oblique aſcending. I affirme that he riſeth ſo much ſooner in this oblique ſpheare, then in a right ſpheare, as 13 deg. &c. cometh unto.

And note further that the aſcentionall difference from one quarter goeth for all the reſt in the ſame latitude.

Chap. XV.

Of the oblique aſcenſions

The oblique aſcenſions, be an arke or point of the Equator, which doe coaſcend with any giuen arke of the Ecliptické or with any ſtarre aboue the Horizon, and found thus. Conſider if the ſignes be North or South, if South, adde to their right aſcenſion the difference of aſcenſion, if North, take the difference of aſcenſion from the right aſcenſion, and the [illegible] of the one, or remainder of the other, is your deſire.

Example.

[illegible] deg. of ♊ is 62 degrees, by the 13 Chapter, the difference [illegible] by the 14, is 29 47/60 deg. Gemini is a North ſigne, therefore I ſubtract the difference viz 29 47/60 from 62, ſo haue you 32 [illegible] deg. the oblique aſcenſion.

[illegible] for the South [illegible] the oppoſite deg. to the [illegible] is 242, to which I adde 29 [illegible] deg. the difference [illegible] by the 14, ſo haue you the oblique aſcenſion of the 4 deg. of Taurus, viz. 271 47/60 deg.

Theſe propoſitions be moſt [illegible] in all Aſtronomicall operations.

Chap. XVI.

Of deſcenſions both right and oblique.

Vnto the oblique aſcenſion of the oppoſite degree to the degree propoſed, adde 180, and ſo haue you your deſire.

Example.

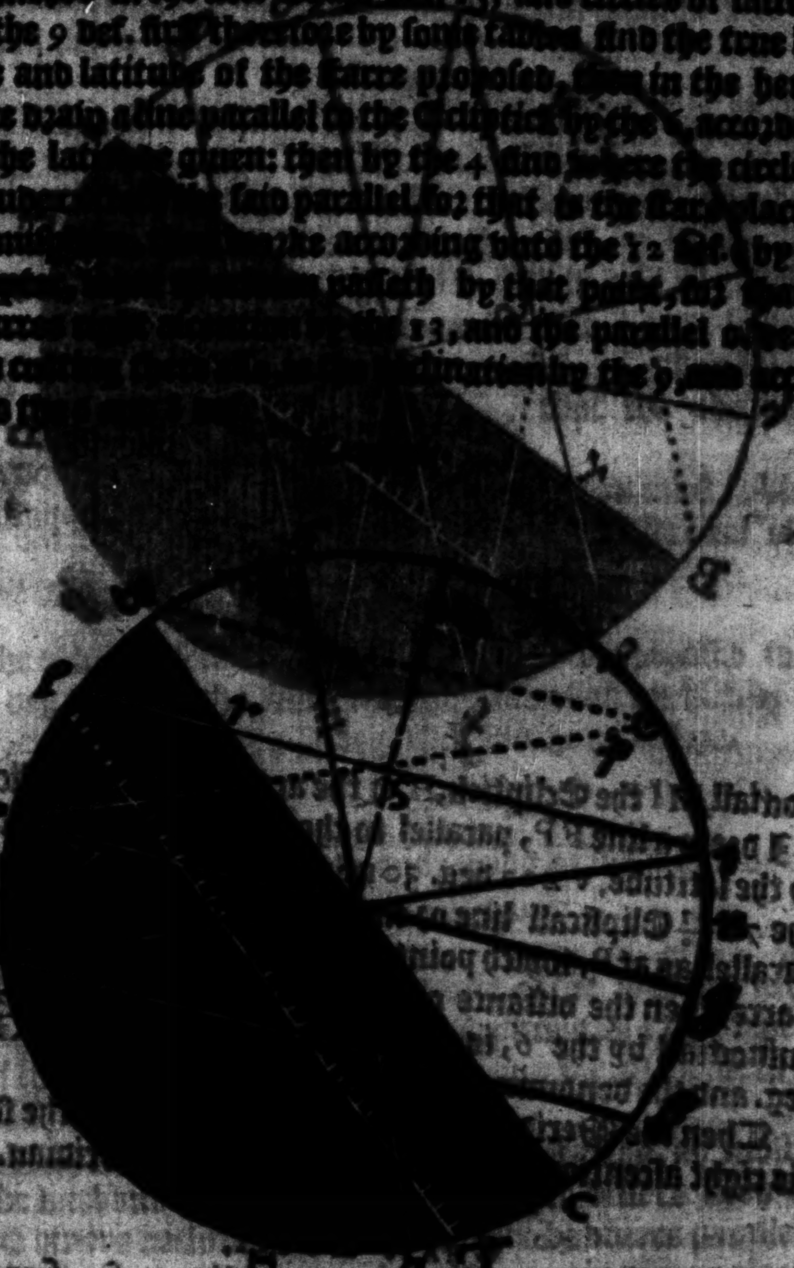
I would find the oblique deſcenſion of the 20 deg. of ♋, therefore I adde 180 vnto 323 deg. 9 min. 34 ſec. the oblique aſcenſion of the 20 deg. of Capr. ſo haue you 503 de. 9 mi. 34 ſec. your deſire, were it not that it doth exceed the whole circle 360, which for becauſe it ſo falleth out, I muſt alwaies in ſuch a caſe ſubſtract 360, as 360 deg. from 503 deg. 9 min. 34 ſec. there remaineth 143 deg. 9 min 34 ſec. your deſire.

Chap. XVII.

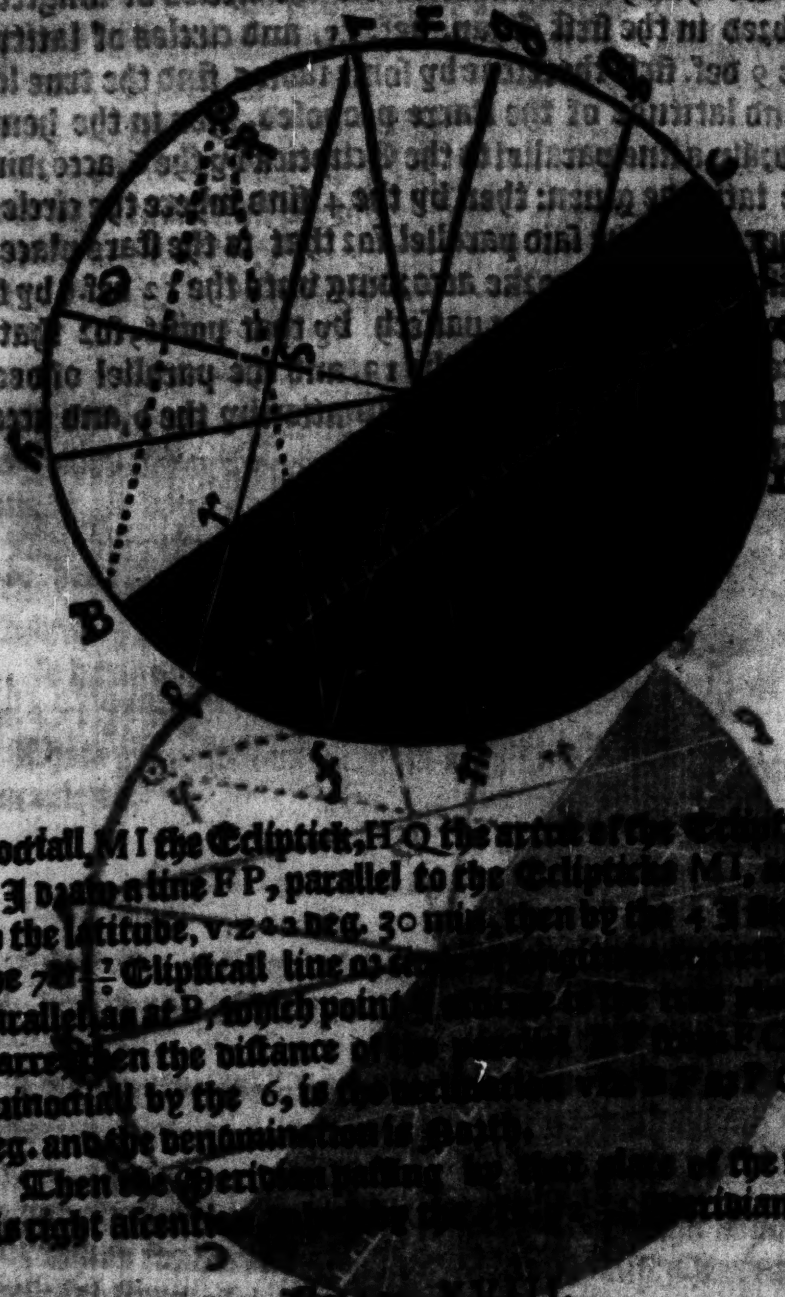
The longitude and latitude of any ſtarre propoſed, to find his right and oblique aſcention together with his declination from the Equinoctiall, and to place any ſtarre in the hemiſpheare.

This matter is eaſily performed by your ſtaffe, vnderſtanding but what is ſaid before, but to the matter.

Here we ſhall haue occaſion to vſe the circles of longitude remembred in the firſt Chap. Def. 15, and circles of latitude as in the 9 Def. firſt therefore by ſome tables find the true longitude and latitude of the ſtarre propoſed, then in the hemiſpheare draw a line parallel to the Ecliptick by the 6. according vnto the latitude given: then by the 4 find where the circle of longitude [illegible] the ſaid parallel, for that is the ſtarres place in the hemiſ[illegible] according vnto the 12 def. by the 4 Chapter [illegible] paſſeth by that point, for that is the ſtarres [illegible] 13, and the parallel of declination [illegible] declination by the 9, and according to [illegible]



There is a faire ſtarre of the firſt magnitude placed in the North, whoſe name is Capella, Hircus, or Alhaoich, in Engliſh the Goate, I find the longitude of this ſtar to be [illegible] in the 16 37 deg. of Gemini, or to be diſtant from the vernall interſection of ♈ 76 [illegible] deg. and that his latitude from the Ecliptick is 22 ½ deg. into the North. I draw therefore as I am wont my hemiſpheare A B C D E, wherein F G is the Equinoctiall



noctiall, M I the Ecliptick, H Q the [illegible] the [illegible], the 1 I draw a line F P, parallel to the Eclipticke M I, according to the latitude, V Z 22 deg. 30 min. then by the 4 I [illegible] where the 7 [illegible] $\frac{7}{60}$ Eclipticall line [illegible] the ſaid parallel, as at P, which point [illegible] of the ſtarre, then the diſtance [illegible] G, the Equinoctiall by the 6, is the [illegible] G, 45 $\frac{8}{60}$ deg. and the denomination is [illegible].

Then the Meridian paſſing [illegible] of the ſtarre is his right aſcen[illegible] meridian.

CHAP. XVIII.

The difference of aſcenſions or the oblique aſcenſion of any point in the Ecliptick propoſed, or of any ſtarre, to find the latitude of the country.

Draw a parallel according to the declination of the point propoſed, then by the 14 number the difference of aſcenſions propoſed upon the ſaid parallel, [illegible] the [illegible] in the [illegible], by which point in the parallel draw a line to [illegible] paſſe by the center touching the peripher, the chord then included betwixt the pole and the interſection of that line with the peripher is your deſire.

Example.

Hauing laid downe a right ſpheare as A B C D E, making F G the Equinoctiall, L I the Tropick of Cancer, let then the queſtion be of the 0 deg. of ♋, whoſe difference of aſcentions let be 34 $\frac{13}{60}$ deg, which I counte by the 4 def. on, L I the Tropick ſtonwards S towards L, which falleth at R. I conclude a line drawne from the circumference by R to A, and ſo to the peripher againe, is the Semihorizon, as B R A C, then E being the pole eleuated I affirme by the 2, that the chord B E limites the eleuation, viz. 52 $\frac{20}{60}$ deg.

The figure in the 17 Chapter ſerueth here.

But if the oblique aſcention be propoſed you muſt ſubtract that from the right aſcenſion, and ſo get the difference of aſcenſions.

Example.

The oblique aſcention of the 0 deg. of ♋ is propoſed to be 55 $\frac{47}{60}$ deg. which take from the right aſcenſion, which by the 13 is 90: ſo haue you 34 $\frac{13}{60}$ deg. then worke as before.

Chap. XIX.

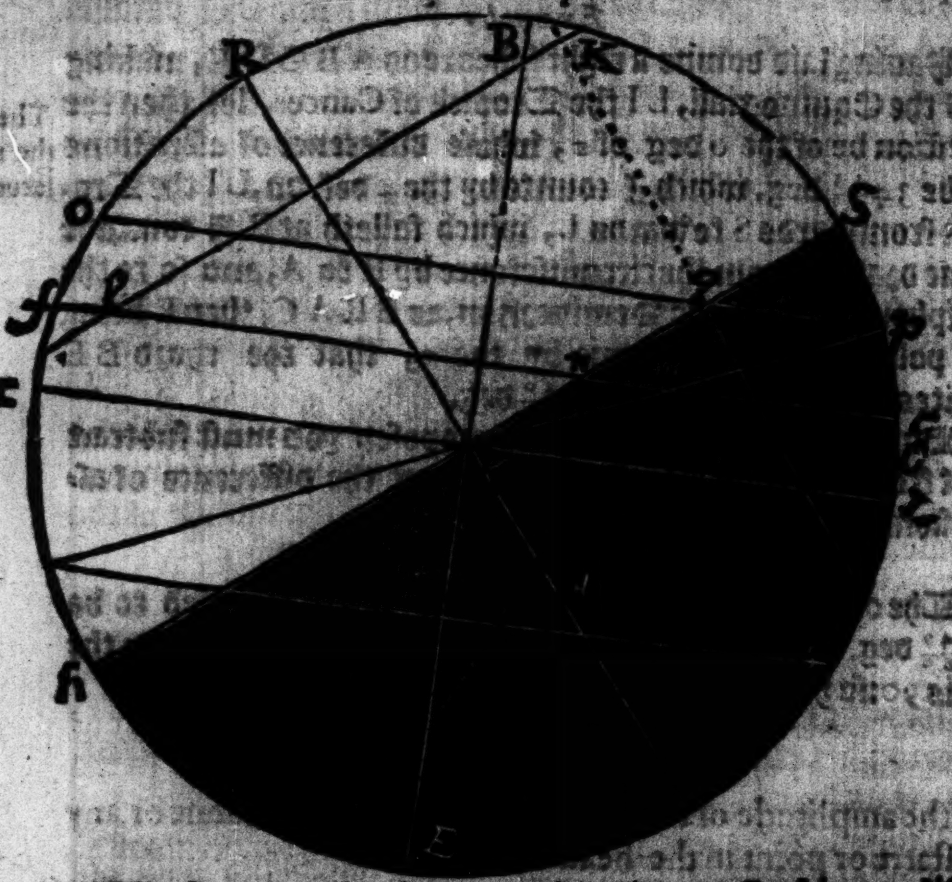
Of the amplitude of the riſing and ſetting of the Sunne or any ſtarre or point in the heauens.

The amplitude of riſing is an arke of the Horizon intercepted betwixt the riſing of the Equinoctiall & the true riſing of the Ecliptick, or the Sunne or any ſtar or point in the heauens.

For whereas the Sunne and other ſtarres, as moſt of them be without the Equator, and by their diuers ſites doe obtaine diuers declinations, and doe deſcribe diuers parallels, by the firſt mouer, which do cut the Horizon in diuers places, then who doth not conſider that there is alſo great variety of the amplitude of riſing, which doth much vary in the ſtarres and points of the Ecliptick, by reaſon of the diuerſe inclination of the Equinoctiall to the Horizon, and the diuers places vpon the earth: but to the matter.

You ſhal therfore lay down an oblique ſphere by the 7 according to ÿ eleuation, thē draw a parallel according to the declinatiō of the ſtar or point whoſe amplitude you ſeeke; note the interſection of the parallel with the Horizon, for the Azimuth or diſtance of that point from the center is your deſire.

Example.



The Sunne being in 0 deg of ♋, I doe deſire his amplitude in the 52 $\frac{20}{60}$ latitude, firſt I lay downe a ſpheare according to my latitude, as A B C D E, F G being the Equinoctiall, O P the Tropicall parallel, B the North pole, H I the Horizon, and I the chord of elevation: ſo then I note where O P the Tropick, and H I the Horizon interſect, as at Q. I conclude Q A is the amplitude then by the 3 Cha. and Chap. 1 def. 14. And ſee that the 40 $\frac{42}{60}$ Azimuth paſſeth by Q which is the true diſtance of Q from A, I conclude that the amplitude of ☉ being in the 0 deg of Cancer, was juſt 40 $\frac{42}{60}$ deg.

Chap. XX.

The amplitude of riſing of any ſtarre knowne, or of the Sunne with his place in the Zodiacke to find the Latitude of the country.

Imagine the amplitude of ☉ being in 0 deg of ♋, were given to be 40 $\frac{42}{60}$ deg.

Let A B C D, be the hemiſpheare, O P a parallell drawne, according unto the declination of the 0 deg. of ♋; then doe I protract a chord from R towards B according unto the amplitude as R B $40\frac{4}{5}$ deg. then from B I draw a line B Q parallel to R A, which ſhal interſect with O P the Tropick at G, I conclude a line drawne from A by Q to the circumference, as H A Q I, is the Horizon, ſo is B I the chord of elevation, which by the 2 is $52\frac{30}{60}$ deg.

The figure laſt before ſerveth here.

CHAP. XXI.

To know the riſing and ſetting of the Sunne, the length of the day and night, with the continuance of twilight.

THe day, after vulgar capacity, is taken two-fold, civill and naturall: the day civill is the ſpace of time wherein one revolution of the equator with the adding of the motion of the Sunne, is full compleate, and is alwaies 24 howers.

The naturall day is a ſpace of time, wherein the Sun is carried from the Eaſt, by the midſt of heaven to the Weſt, and is altered in every ſeverall latitude.

Now the night is the ſpace of time wherein the center of the Sunne is carried from the Weſt by the Imum Cœli to the Eaſt, thus found.

Having laide downe your hemiſpheare, as you be accuſtomed according unto your elevation, draw a parallel according unto the declination of the Sunne for the day propoſed, note then the interſection of that parallel with the Horizon, for the Meridian circle paſſing by is your deſire, viz. the howres of Sunne riſing, and the Azimuth paſſing by that point ſheweth the coaſt.

Example.

I would know the riſing of the Sunne, &c. in the 52 deg. 30 min. of latitude, the ☉ being in no degree ♋, lay downe an oblique ſpheare B D C E, according to ẏ elevation: let B C be the Horizon, E ẏ North pole, L I the Tropicke of ♋, the interſection of ẏ Tropick and the Horizon R: by the 4 I find ẏ the 39 Meridian counted from S paſſeth by R, R is the 6 of clocke Meridian, and 39 deg. by the firſt is 2 howres, 4 deg. therefore the Sunne roſe 4 deg. before 4 in the morning, which is 16 mi. before 4: if you had ſought a ſetting you muſt have counted thoſe deg. forwards from 6, ſo had the ſetting bin 8 deg. after 8 at night.

Then if you adde the howre of Sunne riſing and ſetting together, they make alwaies 12, & if you double the howre of Sunne ſetting you haue the length of the day, that taken from 24 leaueth the length of the night, as double 8 and 4 min. ſo haue you 16, 8 min. the length of the day, which taken from 24, there remaineth $7\frac{52}{60}$ howers, the length of night.

Otherwiſe.

By the 14, learne the difference of aſcenſions, which by the firſt reduce into time, which take from 6, if the Sunne haue declination toward the pole eleuated, or adde to 6, if the Sun haue declination from the pole eleuated, the remainder of the one, or totall of the other is your howre of ☉ riſing.

Then the howre of Sunne riſing taken from 12 sheweth the howre of Sun ſetting, which doubled, sheweth the length of the day as before.

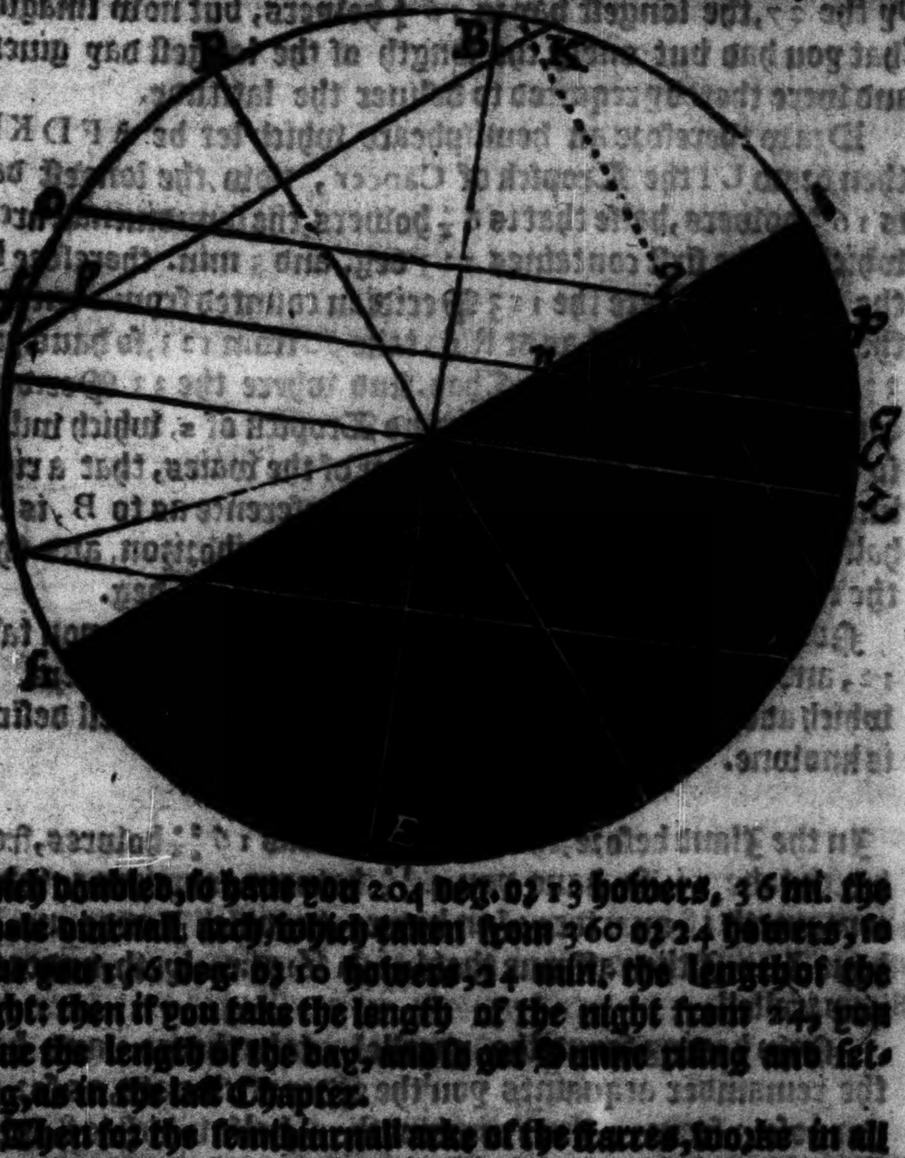
Now for the continuance of twilight, draw a parallel 18 deg. vnder the Horizon, then the portion of the parallel of the Sun included betwixt that line of depreſsion laſt drawne, and the Horizon is your deſire, whereby you may gather that in ſummer we haue no ending of twilight, but all day, for that the circle of depreſsion L T drawne 8 deg. vnder B C, the Horizon doth not reach L I the Tropick of Cancer, whereas otherwiſe when the Sunne is in the Equinoctiall F G we haue a great twilight, for that the portion of the Sunnes parallell A V is great, containing by the thrée aboue 30 deg. which is more then two houres: and ſo long is it then that twilight doth beginne before Sunne riſing called commonly the breake of day, and ſo long likewiſe doth it endure after Sunne ſet.

So that you ſée in ſummer for a certaine ſpace we haue all day, and in other times a kind of twilight, which is nothing elſe but diſtinction of day and night, or lightnes and darknes made by reaſon of ẏ refulgent beames of the Sun which cannot quite be obſcured vntill he be 18 degrées below the Horizon.

Chap. XXII.

To know the Semidiurnall arch of the Sunne or ſtarres with the length of day and night, &c.

Let the queſtion be to know the ſemidiurnall arch of the 25 deg. of ♈, in the 52 deg. of latitude, lay downe your oblique hemiſpheare according to your latitude as you be wont, which let be A B C E D, let C D be Equinoctiall, and let F G be a parallel drawne according to the declination of the 25 deg. of ♈, which let interſect with H I the Horizon at N: I then conclude that I N is the ſemidiurnall arch of ☉ being in the 25 deg. of ♈, which by the 4 I find to be 102 deg. or 6 howers, 48 min.



which doubled, ſo haue you 204 deg. or 13 howers, 36 mi. the whole diurnall arch, which taken from 360 or 24 howers, ſo haue you 156 deg. or 10 howers, 24 min. the length of the night: then if you take the length of the night from 24, you leaue the length of the day, and ſo get Sunne riſing and ſetting, as in the laſt Chapter.

When for the ſemidiurnall arke of the ſtarres, worke in all reſpects with their parallell of declination as you did with the Sunnes, and you haue your deſire; and ſo ſhall you find the informed ſtarre vnder the belly of Leo, to agrée very néere with the former.

Chap. XXIII.

The quantity of the longeſt day of any country given, to find the eleuation of the pole, and to diſtinguiſh the climats.

The Coſmographicall tables ſhew that the Iland called Inſula Ziriſæa, containeth in latitude 52 deg. and therfore by the 27, the longeſt day is 16 $\frac{2}{4}$ howers, but now imagine that you had but onely the length of the longeſt day giuen, and were thereby required to deliuer the latitude.

Draw therefore an hemiſpheare which let be AFDKE, then draw L l the Tropick of Cancer, now the longeſt day is 16 $\frac{2}{4}$ howers, halfe that is 8 $\frac{1}{4}$ howers, the ſemidiurnall arch, which by the firſt containes 123 deg. and 3 min. therefore by the 4, I find where the 123 Meridian counted from I cutteth the Tropicall parallel as at R, or take 90 from 123, ſo haue you 33, then by the foreſaid 4 Chap. find where the 33 Meridian counted from E paſſeth, by the ſaid Tropick of ♋, which wil alſo fall out at R: I conclude by either of the waies, that a right line drawne from A by R to the circumference as to B, is the halfe ſemihorizon, and C B the whole ſemihorizon, and that the chord B E is the eleuation of the pole viz. 52 deg.

Now ſaith Gemma Friſius, if out of the longeſt day you take 12, and reduce the remainder into quarters of howers, to which adding one, the number or order of the parallell deſired is knowne.

Example.

In the Iland before, the longeſt day was 16 $\frac{30}{60}$ howres, from which take 12, ſo haue you 4 $\frac{30}{60}$ howres remaining, which containeth 18 quarters of an howre, to which I adde one, ſo haue I 19. I then affirme that Inſula Ziriſæa lyeth vnder the 19 parallell.

Now hauing found the parallel, take thence 3 and halfe the remainder acquaints you the order of climats, as for the purpoſe, 3 from 19 there remaineth 16, halfe which is 8, which ſheweth that they doe inhabite in or vnder the 8 climate.

Chap. XXIIII.

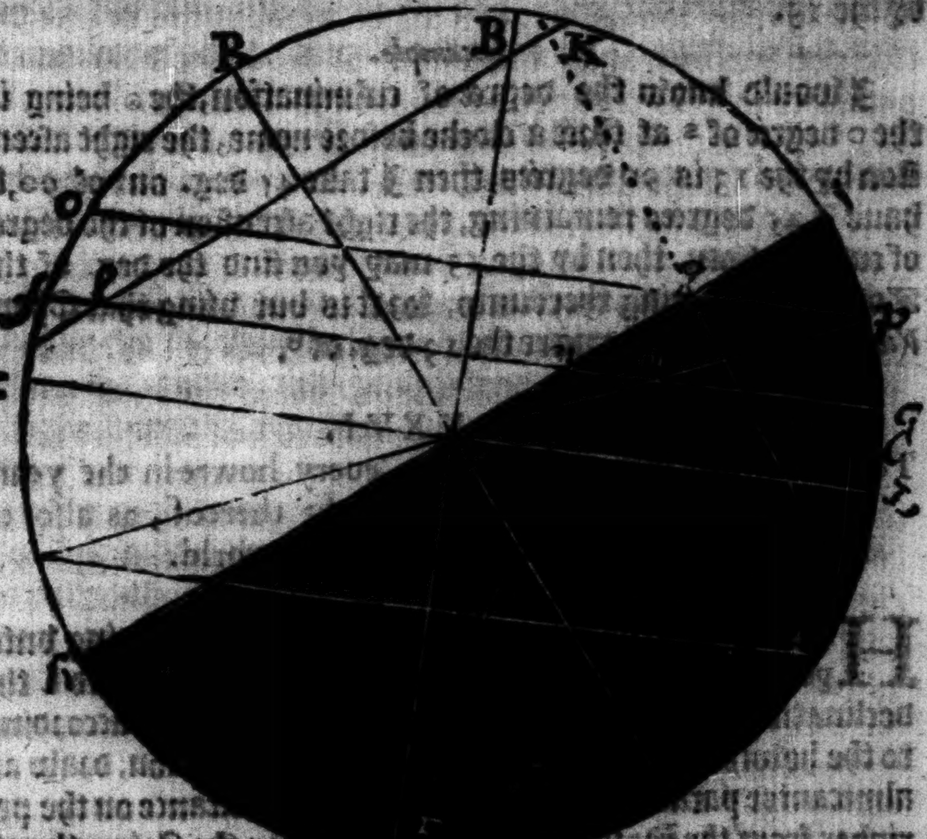
To know the Meridian altitude of the Sunne or any ſtarre.

The Meridian altitude of the Sun or any ſtar, is the greateſt altitude that either of them can haue, & is found thus.

Lay downe an hemiſpheare according unto the latitude, and then draw a parallel according to the declination of the Sunne or Starre propoſed, the chord then that is intercepted betwixt the Horizon and the parallell counted upon the limbe, is your deſire.

Example.

The Sunne being in the 0 degree of ♎, I would know his



Meridian altitude here at London.

Let A B C E D, be your hemiſphere, C D the Equinoctiall, O P a parallell drawne according to the declination of the 0 degree of ♎, H I the Horizon, then do I conclude that the chord O H is your deſire, which by the ſecond is found 62 deg.

The figure in this Chapter wanteth here.

CHAP. XXV.

To finde the degree of Medium Coeli, or Culmination at any time propoſed.

The degrees of the Eclipticke any time being in the Meridian, is called *Gradus Medii Coeli*, with ſome, *Cor Coeli*, but moſt generall, *Culmen Coeli*, thus had.

YOu muſt take the right aſcenſion of the degree propoſed, & then get this diſtance from the Meridian line in degrees:

then foꝛ the foꝛenone howres, take the diſtance from the right aſcenſion, adding 360, if otherwiſe ſubſtraction cannot be made, and then make ſubſtraction: but foꝛ afternone howres, adde the aſcenſion to the diſtance, caſting away 360, if the whole ſumme excéede 360; ſo haue you the right aſcenſion of the culminating, then the deg. of the Zodiack is found by the 13.

Example.

I would know the degrée of culmination, the ☉ being in the 0 degrée of ♋ at thꝛée a clocke befoꝛe none, the right aſcenſion by the 13 is 90 degrées; then I take 45 deg. out of 90, ſo haue I 45 degrées remaining, the right aſcenſion of the degrée of culmination: then by the 13 may you find the deg. of the Zodiack anſwering thereunto, foꝛ it is but uſing that Chap. *Vice verſa*, ſo will it be néere the 13 deg. of ♉.

Chap. XXVI.

To know the heigth of the Sunne, every howre in the yeare above the Horizon without the ſight thereof; as alſo to find the Azimuth in any region of the world.

Having laid downe your hemiſpheare accoꝛding unto your latitude, dꝛaw then a parallel accoꝛding unto L the declination, and find a Meridian cutting the ſame accoꝛding to the howre aſſigned, by which point of interſection, dꝛaw an almicanter parallel to the Hoꝛizon, whoſe diſtance on the peripher from the Hoꝛizon is your deſire, then the Azimuth paſſing by that point alſo, is the verticall circle.

The figure in the 11 Chapter ſerueth here.

Example.

Upon the 10 day of Apꝛill 1607, I deſired the altitude of the Sunne at London, iuſt at ten of the clocke befoꝛe none.

Firſt, I laid downe the hemiſpheare A B C E D, accoꝛding to the latitude, C D being the Equinoctiall, B E the Noꝛth and South pole, H I the Hoꝛizon, R the Zenith, then is F G a parallell dꝛawne accoꝛding unto the Sunnes declination 11 $\frac{40}{60}$ deg. next is L a point by the 4, where the 10 of clocke howerly, oꝛ 60 Meridian counted from B, paſſeth by: then is I K an almicanter, dꝛawne by the point L accoꝛding to the 7 def. the arke of whoſe diſtance from the Hoꝛizon as I H, is the altitude of the Sunne, 46 $\frac{1}{60}$ deg. then the Azimuth by the 14 def. paſſing by L, ſhew the Azimuth oꝛ verticall circle that the

Sunne was in, reckoned from R, which by the 4 I found 42 or there abouts: whereby I might conclude that the Sun was 47 deg. diſtant from the Eaſt into the South.

And by this meanes may you find the points of the compaſſe, than the points of the compaſſe be 32, which deuide by 306, the quotient is 11 $\frac{1}{4}$ deg. which in one point, then deuide 47 the Azimuth by 11 $\frac{1}{4}$ deg. the quotient doth yield the number of points from the Eaſt to be 4, which is South-eaſt.

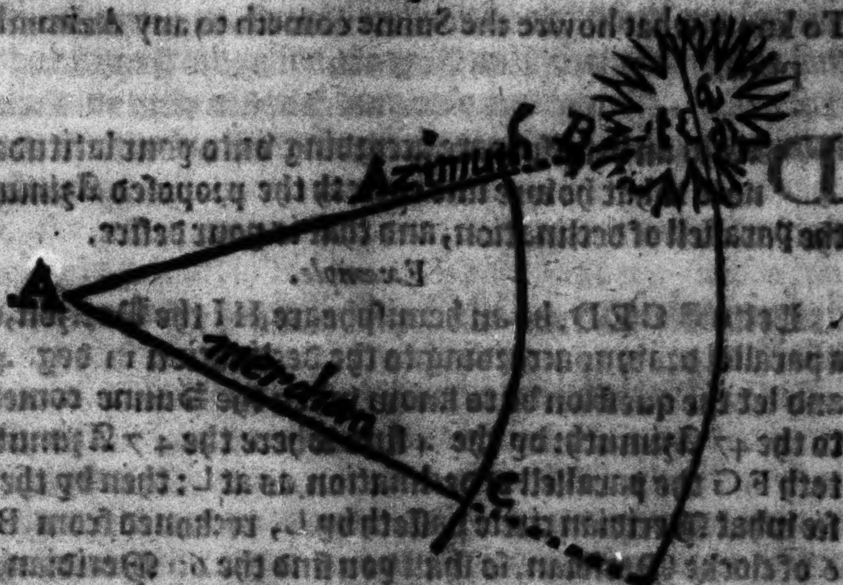
Chap. XXVII.

To find the Meridian and foure quarters of the world by the Geodericall ſtaffe.

By the laſt Chap. you ſhall get the Azimuth of the Sunne, or by the 28, then ſhall you draw a line to point directly towards the Sunne, and then protract an angle according to the Azimuth, and that line repreſents the true Meridian.

And you muſt note if you worke according to the finding of the Azimuth in the laſt Chap. you muſt remember to note this Azimuth counted from the South.

Example.



The figure in the 11 Chapter ſerueth here.

By the laſt Chap. I found the Sunne was 47 deg. diſtant from the Eaſt, and therefore 43 deg. diſtant from the Meridian, I draw therefore a line A B to point ſtill towards the

Sunne, then I protract an angle of 45 deg. B A C: I conclude the line A C lieth iuſt vnder the Meridian.

In like manner may you doe with the legs without protracting any angle.

And you muſt note, if the Sunne were Eaſt from the Meridian, you muſt protract the foreſaid angle on the right hand: if Weſt on the left.

Chap. XXVIII.

To find the Azimuth of the Sunne.

Conſider if the Sunne be on the Eaſt or Weſt ſide the Meridian, if on the Eaſt, aply a néedle to the right legge: if on the Weſt, to the left leg, in ſuch ſorte that the Meridian line in the card vnder the néedle may lye parallell to the legge he is applied vnto: then cauſe the néedle to ſtand iuſt ouer the Meridian in the card, & open the other leg, vntill the ſhadow of the ſight placed therein agrée with the fiduciall edge of the leg: then note the quantity of the angle, for the diſtance of the Sunne from the South, or Azimuth of the Sunne.

Chap. XXIX.

To know what howre the Sunne cometh to any Azimuth propoſed.

Draw an hemiſpheare according vnto your latitude, then note what howre line cutteth the propoſed Azimuth on the Parallell of declination, and that is your deſire.

Example.

The figure in the 11 Chapter ſerueth here.

Let A B C E D, be an hemiſpheare, H I the Horizon, &c. F P a parallel drawne according to the declination 11 deg. 40 mi. and let the queſtion be to know when the Sunne cometh vnto the 47 Azimuth: by the 4 find where the 47 Azimuth cutteth F G the parallell of declination, as at L: then by the ſaid 4 ſée what Meridian circle paſſeth by L, reckoned from B E the 6 of clocke Meridian, ſo ſhall you find the 60 Meridian, therefore by the firſt I conclude that the Sunne cometh to the 47 Azimuth according as is ſaid, at the preciſe howre of 10 of the clocke before noone: for 15 the number of degrees in one Horizon is in 60, 4 times, which is 4 howres, & that added to 6 howres maketh 10, as before.

CHAP. XXX.

Another way moſt eaſy and true to know the howre of the day.

YOu ſhall obſerue by the 28 Chap. or ſome other way the Azimuth of the Sunne, and then lay downe the [illegible] according to the latitude, and draw a parallell according unto the declination of the Sunne: note then where the Azimuth and the parallell of the Sunne interſect, for the Meridian paſſing by ſheweth the howre deſired.

Example.

Lay downe your hemiſphere A B C E D, let H I be the Horizon, F G a parallell drawne according unto the declination $11\frac{40}{60}$ deg. let the Azimuth by the 28 Chap. be 43 degr. diſtant from the South, which let cut F G at L: then by the 4 ſee what Meridian paſſeth by that point as by L, which you ſhall find the 60, reckoned from the 6 of clocke line E, therefore it is 10 before noone, or 2 after noone, but becauſe my obſeruation was before noone, it is 10.

The figure in the 12 Chapter ſerueth here.

I could inlarge this Booke greatly in matters Aſtronomicall, as to teach you how to erect a figure to find the beginning quantity and duration of Eclipſes, to obſerue the motion of the Starres, &c. would my occaſions afford me ſo much time: but ſince I am called away, I will onely teach you how to make ſome kinde of dials, very eaſy and ſpeedy, and ſo conclude the Booke with certaine pleaſant Geographicall propoſitions.

Here ends the firſt part of the eighth Booke, called Planiſphera.

HOROMANCI, OR THE ART OF DIALLING

By the Geodeticall ſtaffe,

Containing the making of many, or rather, moſt Dials, without other helpe.

Chap. XXXI.

To make an horizontall horoſcope or Diall in any oblique Horizon, with the theoricall ground thereof.

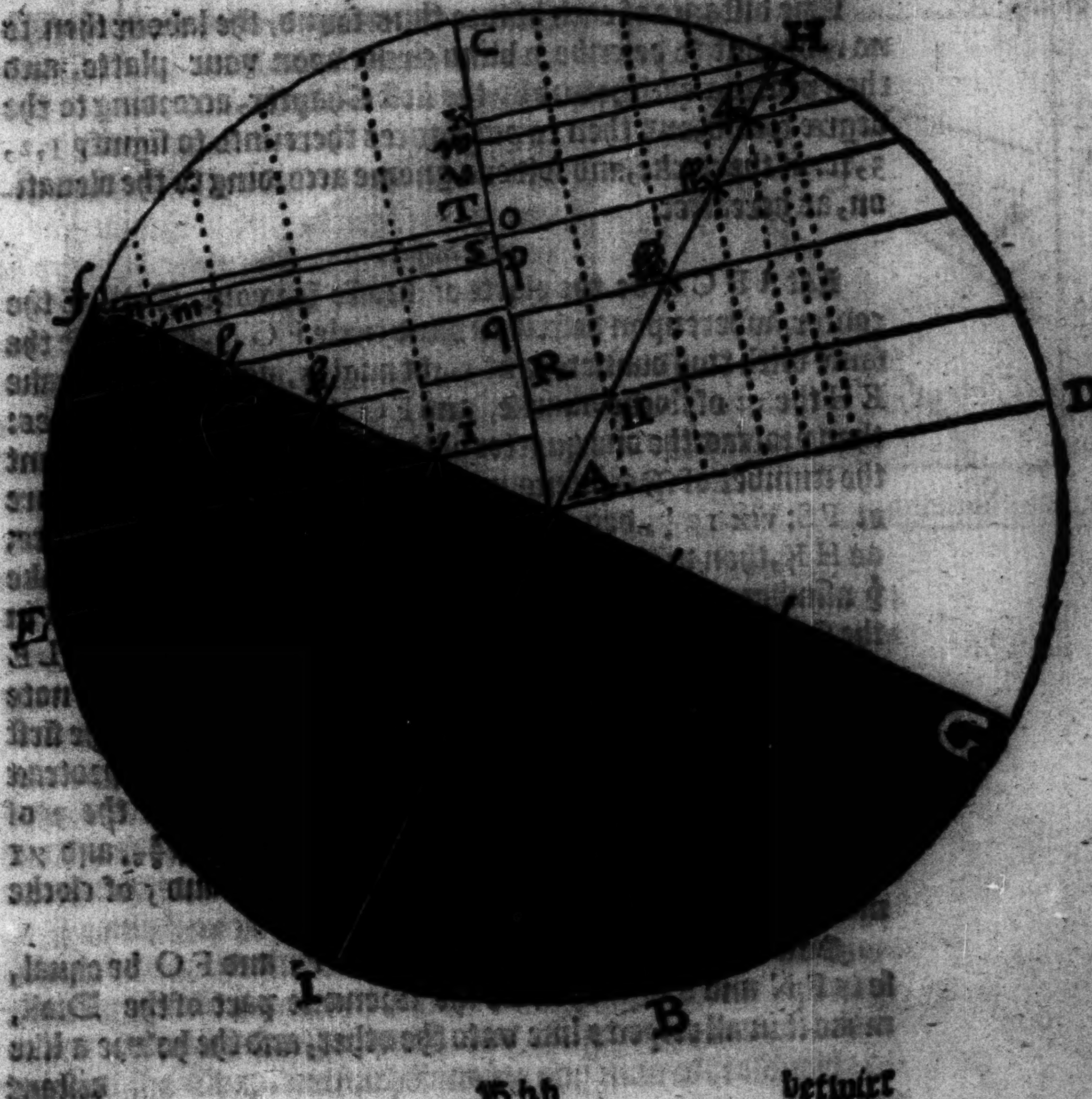
TO make an Horizontall Diall is no other thing then to find how many degrees of the Horizon is contained betwixt euery 15 Meridian, ſo that euery howre in the Diall doth comprehend 15 Meridians: therefore if the Meridians in the heauen were viſible to the eye, if you did but ſtand in the South part of the Diall, and behold the North, you ſhould ſee that the 12 of clocke would iuſt point to the North part of our common Meridian, & that 11 or one of the clocke would decline from the 15 Meridian into the Eaſt or Weſt, and ſo 10 or 2 of clocke to the 30. &c. Whereupon you may gather, that the leſſe the pole is eleuated, the leſſe the howres be towards noone, and the greater towards euening, becauſe the Meridians anſwering to the middeſt of the day be neerer together, becauſe their diſtance is taken neere the pole, as concurring at a common center: and further diſtant in the euening, becauſe they point or anſwere to the Meridians in the middeſt of the ſpheare, which are ſo much the greater by how much the pole is leſſe eleuated, by reaſon of the oblique ſection of the Horizon. And as I diſtinguiſh the howres in any Horizontall Sunne Diall by the number of the Horizontal.

equall degrees included betwixt every 15 Meridians, ſo likewiſe it ſhall come all to one paſſe, if you take the number of Meridians included betwixt the ſection of every 15 degrees of the Horizon: the onely difference is, that the axis line or 6 of clocke Meridian in this worke, muſt be the 12 of clocke line.

Let A E C D be an hemiſphere, and let the propoſition be to make an Horizontall Diall to the 53 degree of latitude, which may aptly enough be applied to the latitude of the Towne of Shrewſbury.

Let C be the North pole, B the South, F G the Horizon, erected according to the elevation 53 deg. as F C: let H be the Zenith, C B the 12 of clocke Meridian.

The firſt thing then that we be to doe, is to find the diſtance



betwixt every 15 deg. upon the Horizon A F, counting towards A, which by the 14 def. of the firſt, is performed by Azimuths, then it is eaſy by the 3 Chapter at 2 to find, where every 15 Azimuth cutteth, ſo ſhall you find A I to be 15, and there the 15 Azimuth cutteth A K to 30, A L 45, A M 60, A N 75, and A F 90: then are you to counte what number of Meridians counted from A paſſe by each of thoſe points, which the 4 Chapter will eaſily performe, which limits the diſtance of one howre from another in deg. ſo ſhall you find the 12 $\frac{5}{60}$ Meridian to paſſe by I, the 24 $\frac{41}{60}$ by K, the 38 $\frac{17}{60}$ by L: the 54 $\frac{8}{60}$ by M, the 71 $\frac{38}{60}$ by N, and the 90 by F, as is plaine by the pricked lines and the foreſaid 4 Chapter: ſo then have you found the one quarter of your Diall, by which all the reſt is made.

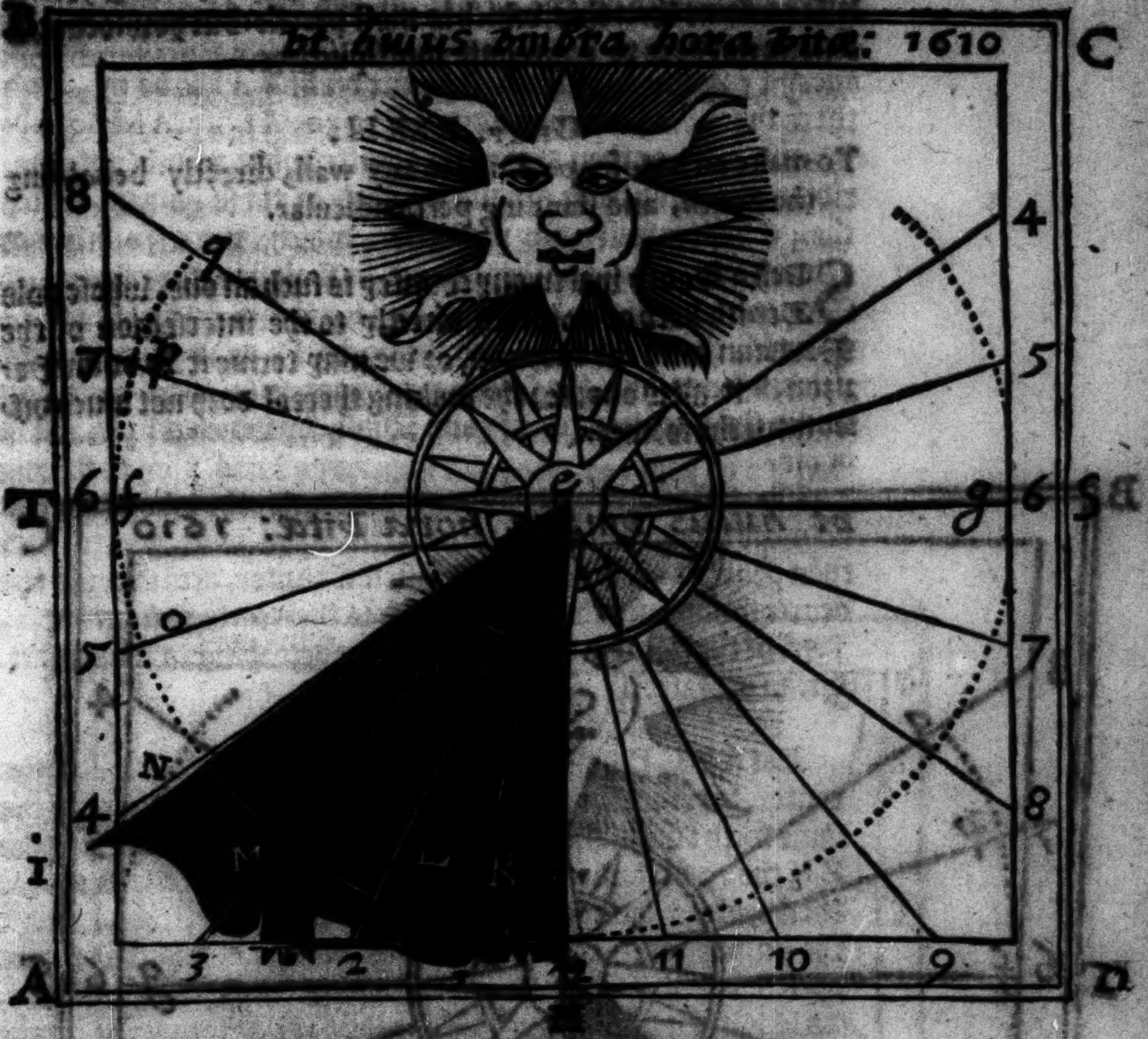
The diſtance of each howre thus found, the labour then is no more but to deſcribe a blind circle upon your platte, and then protract each howre by the firſt Chapter, according to the degrée found, and then to put figures thereunto to ſignify 1, 2, 3, &c. of the clocke, and ſolder a gnome according to the elevation, as hereafter.

Example.

Let A B C D be the platte of braſſe for your Diall, E the center, whereupon deſcribe a blind circle F G H, and croſſe the ſame with two diameters at right angles, as F G H E: make E H the 12 of clocke marke, and F G the 6 of clocke markes: then protract the one quarter of the Diall, as H F, then count the number of Meridians included betwixt F A, in the 3 figure or F S: viz. 12 $\frac{5}{60}$ deg. from H towards F in the following figure, as H K, then draw ye line E K for the 1 of clocke line: next take ye number of Meridians included betwixt A and K, or K R in the firſt figure, viz. 24 $\frac{41}{60}$ deg. and then protract the angle L E H 24 $\frac{41}{60}$ deg. ſo have you E L the 2 of clocke marke: next note the number of Meridians included betwixt A and L in the firſt figure, or L and Q, viz. 38 $\frac{17}{60}$ degrees, and then from H protract H E M an angle of 38 $\frac{17}{60}$ degrees, ſo have you E M the 3 of clocke marke: do ſo with M A and N A, as with 54 $\frac{8}{60}$, and 71 $\frac{38}{60}$ degrees, ſo have you E N and E O, the 4 and 5 of clocke markes, the 6 of clocke is F E.

Now for the howres beyond 6 to 8, F P, and F O be equal, ſo is F N and F Q, then for the forenoone part of the Diall, make it in all reſpects like unto the other, and the howre a like

diſtant



diſtant from 12 of clocke, as 1 and 11, 2 and 10, 3 and 9, 4 and 8, &c. and by this meanes I hope you may make a diall as preciſely as by any inſtrument whatſoeuer.

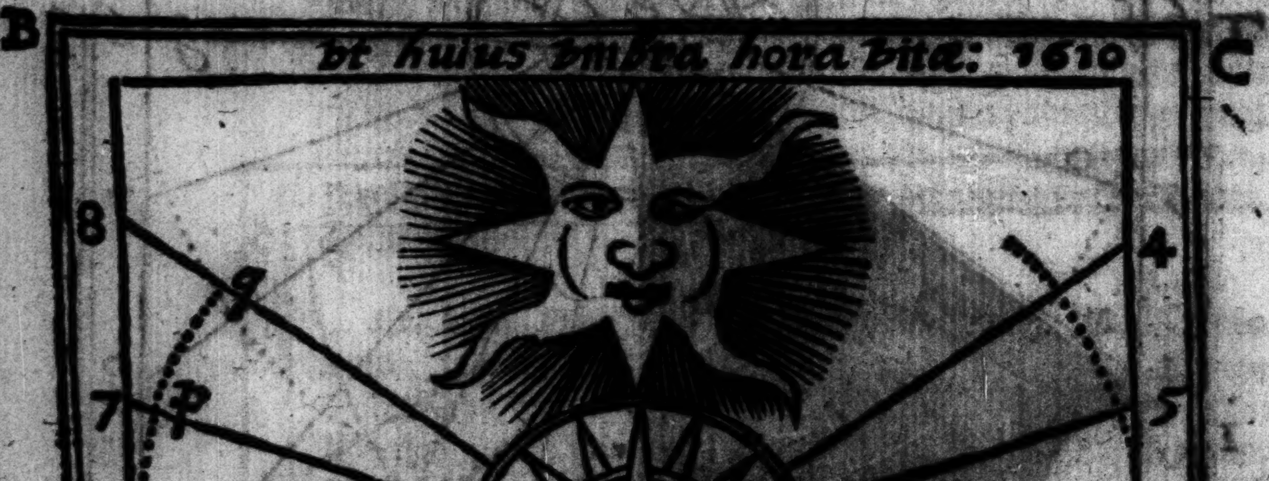
Now for the gnome note the eleuation as 53 degrees, according to which protract an angle of 53 degrees, as I E H: I conclude the tryangle ſhadowed with lines as I E H, is the true patterne of the cocke or gnome H E, being ſouldered faſt on the Meridian at right angles with the plate.

I could here you teach another way to deſcribe this kinde of Dial, but by this inſtrumēt more troubleſome, the ſame more agreeing to the ground of Dials, as by the ſection of euery 15 Meridian with the Horizon, as is remembred in the beginning of the Chap. notwithſtanding any man of reaſonable capacity may eaſily conceiue the making thereof, but I hold it leſſe certaine then this, which is moſt preciſe: but howſoeuer, I entend not here to aggregate multiplicities.

Chap. XXXII.

To make an horoſcope Diall to any wall, directly beholding the South, and ſtanding perpendicular.

Such a South wal in any country is ſuch an one, whoſe pole Zenith lieth or pointeth directly to the interſection of the Meridian with the Horizon, or we may terme it to be an Horizon, but all is one: for the making thereof doth not much differ from the former.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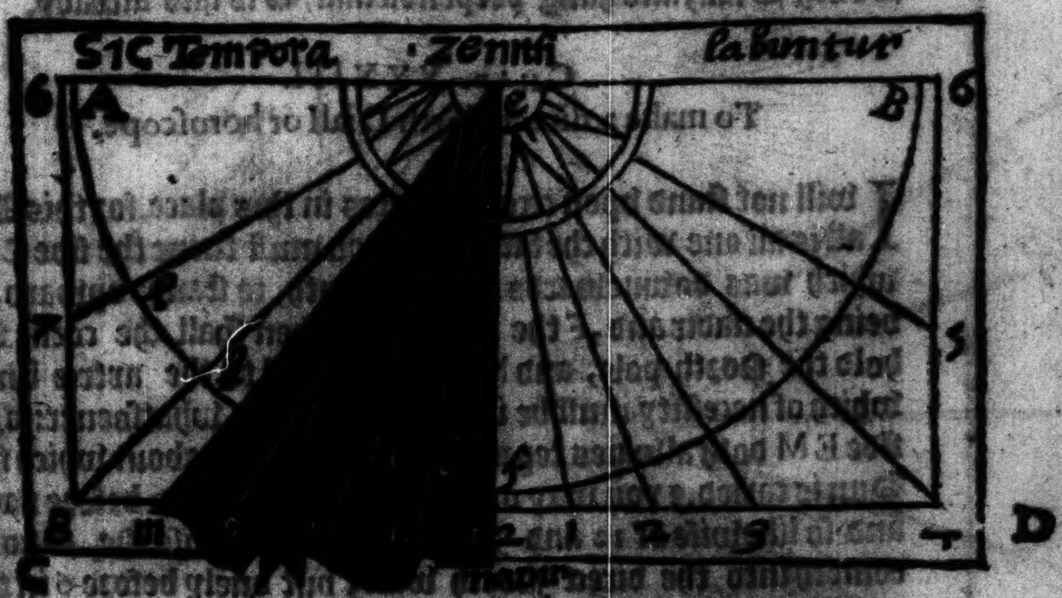
Hauing therefore drawne your Horizon F G according to the eleuation as in the laſt Chapter, make the ſame with another line at right angles iuſt ouer the center, as H I, then make I H the Horizon, and worke in all reſpects as in the laſt Chap. for the finding out of the howres.

Example.

Hauing made I H the Horizon, working as you were inſtructed in the laſt Chapter, you ſhall find that the 9 $\frac{10}{60}$ Meridian paſſeth by H, and ſo many deg. muſt the 11 or 1 of clocke line ſtand from 12: then proceeding you ſhall find the 19 $\frac{2}{60}$ Meridian paſſe by K K, and ſo much muſt the 10 or 2 of clocke line ſtand from 12: then by L L paſſeth the 31 $\frac{4}{60}$ Meridian, by 4 the 46 $\frac{11}{60}$ Meridian, by 5, 66 Meridian is ſo the 6 of clocke H endeth at 90, whereby you may alſo perceiue, that in a direct South Diall there can be placed but 12 howres, as 6 before



noone, and 6 after noone; therefore hauing found the diſtance of your howre lines, fall to protract thus.

Let A B C D be a bord, or ſuch like, to make your Diall vpon; vpon the midſt of A B, as E, erect a perpendicular E F, and then on E as a center, deſcribe the ſemicircle A F B; make E F the 12 of clocke line, then in the quadrant A F, protract by the firſt Chap. an angle of 9 $\frac{10}{60}$ deg. as F E G, ſo ſhall E G be the 11 of clocke line: and ſo do all ẏ other howres found according as in the laſt Chap. ſo ſhall F H containe 19 $\frac{2}{5}$, D F I 31 $\frac{1}{5}$ deg. F K 46 $\frac{1}{5}$ deg. F L 60 deg. and F A 90 deg. this ſide of your Diall made, the other for the after noone is made in the ſame manner, then put figures thereunto according as in the demonſtration.

Now to make a gnomon or ſtile for this Diall, you muſt take 53 degrees the elevation of your pole out of 90, ſo haue you 37 degrees, and then from F protract an angle of 37 deg. as F E M, which is the height of the gnomon, and the line E F muſt alwaies be placed very perpendicularly upon the wall, and ſo haue you finiſhed your South Diall: and note that in the former of the 2 figures, the chord C H, is alwaies equall to the height of the ſame in a South Diall.

Now the difference of placing this Diall from the former, is that the ende of the racke, which pointes into the South in an Horizontall, muſt lie in the Zenith here in this verticall or South Diall, and hang perpendicular, as is ſaid already.

CHAP. XXXIII.

To make a direct North Diall or horoſcope.

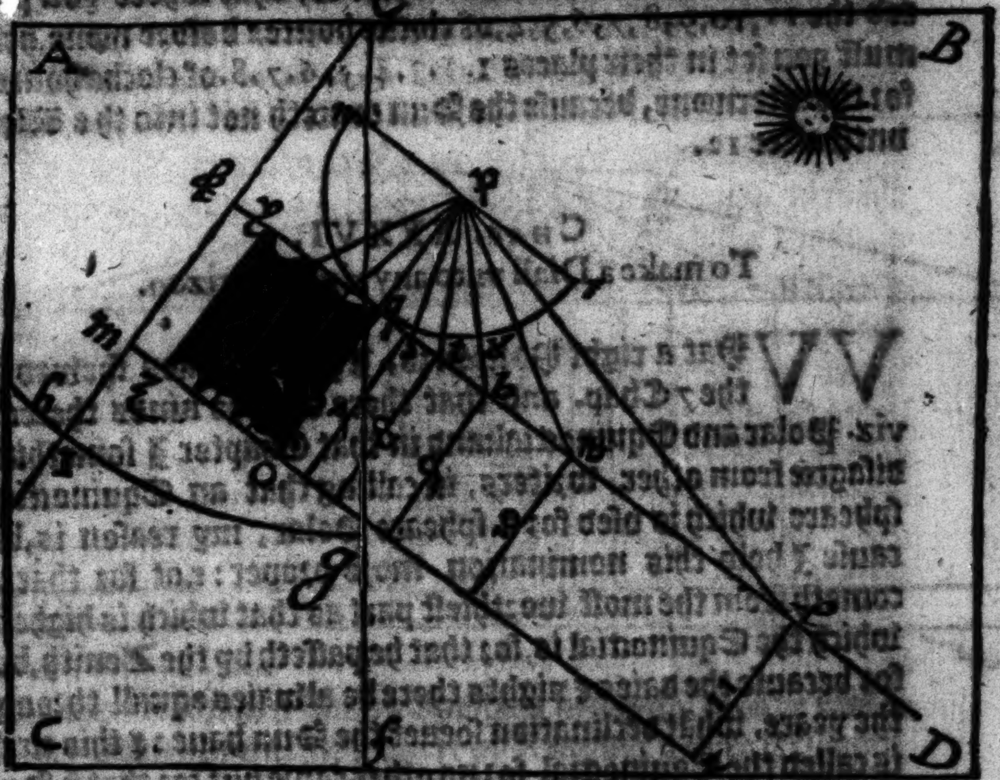
I will not ſtand upon circumſtances in this place, for this Diall is all one with the laſt, onely you muſt turne the line C D which was downewards in the South, to ſtand upward, E being the nadir and, F the [illegible] then ſhall the cocke behold the North pole, and M E [illegible] to the axtre line, which of neceſſity muſt be in [illegible] whatſoever: for ŷ ſide E M doth alwaies repre[illegible] about which the Sun is caried, & you may omit ŷ houres of 11, 10 & 9 before noon, and ſo likewiſe of 12 and 3 after noone, becauſe the Sunne commeth into the direct North wall, but onely before 6 in the morning, and after ſixe at euening.

CHAP. XXXIIII.

To make a Diall to a direct Eaſt wall, called a verticall horoſcope.

Let A B C D be an Eaſt wall, whereon draw a perpendicular line, then note ŷ elevation of your pole for ŷ country where you make the Diall viz. 53 degrees, which take from 90, ſo haue you 37 degrees the height of the Equinoctiall: then from the perpendicular E F drawe an arch on the South line the ſame, and in any place of the perpendicular as G fit: then from G protract an angle of 37 degrées as G I, & there unto the line E F which repreſenteth the axtree of the worlde, and with his parallel therewith: ſo is alſo F E G the true patten of the cock for the South Diall: but to the purpoſe, from any pointe in the line E F drawe a perpendicular as K L: where it toucheth heauenly you ſhall haue your Diall, and accordingly drawe another line parallell thereunto as M N, ſo is your Diall prepared to any wiſe declination.

In any place of your diall towardes the South end drawe a line ouerthwarte the Diall perpendicular to K L, and extende that line beyond the Dial as O P, then on the point P making P Q ẏ diameter of a circle, deſcribe a ſemicircle according as you



ſée C Q R, then from Q towardes R protract an angle of 15 degrées as Q S, then drawe a line from Q by S to cut the line K L, as at S, and ſo to euery 15 degrée, in the quadrant Q R extending the lines untill they make ſection with K L, ſo ſhall Q T be 30 degrées, Q R 45 degrées, &c. and ſo ſhall the lines drawne by thoſe number make ſection with the line K L at S T V W and L, then from S drawe a line parallel to O Q, for ẏ 7 of clocke line, as is from F for the 8 of clocke line, and ſo likewiſe from V, W, and L, for the 9, 10, and 11 of clocke lines: then for 4 and 5 before 6, make thoſe howres equall to 8, and 7 after 6; then putting figures to howres as in the demonſtration, the howre lines be finiſhed.

Now for the cocke of this Diall, he muſt not be made like to a tryangle, but as a parallelogram like to Q O Y Z, containing the iuſt height of the ſemidiameter P Q, he muſt be placed in the 6 of clocke line at right angles with the wall.

Chap. XXXV.
Of an Weſt Diall.

VVOrke in all reſpects, according vnto the laſt Chap. onely this difference there is, that where you placed the 11, 10, 9, 8, 7, 6, 5, 4, of clocke houres before noone, here muſt you ſet in their places 1. 2. 3. 4. 5. 6. 7. 8. of clocke houres for the afternoone, becauſe the Sun commeth not into the Weſt vntill after 12.

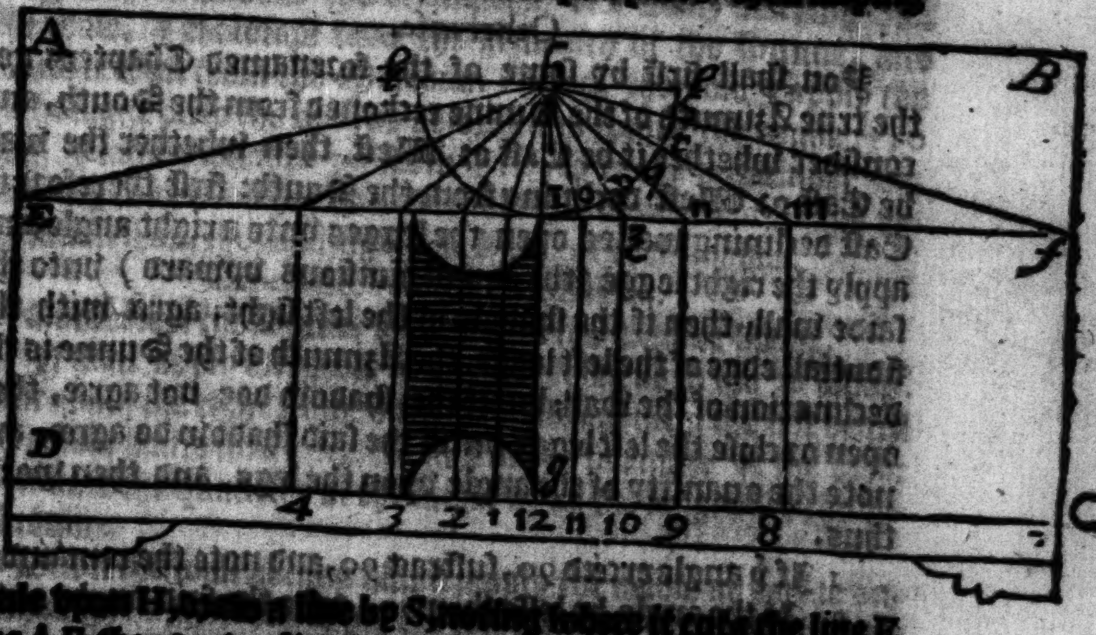
Chap. XXXVI.
To make a Diall vnto any right Horizon.

VVHat a right Horizon is, I haue already ſhewed in the 7 Chap. and that there be two kinds thereof, viz. Polar and Equinoctial: and in that Chapter I ſomething diſagree from other Writers, in calling that an Equinoctiall ſpheare which is vſed for a ſpheare Polar, my reaſon is, becauſe I hold this nomination more proper: not for that it commeth from the moſt worthieſt part as that which is higheſt, which the Equinoctial is, for that he paſſeth by the Zenith, but for becauſe the daies & nights there be alwaies equall through the yeare, what declination ſoeuer the Sun haue: & this circle is called the Equinoctial for no other cauſe but for that ẏ Sun being there doth make equall daies and nights through the world, onely that Horizon excepted which they terme the Equinoctiall Horizon: for the Sunne being there in that circle, he beginneth either to depart out of ſight, or remaine in ſight for halfe the yeare, ſo that in that Horizon, there is neither equall day or night at any time; and therefore the denomination of ẏ ſpheare ſhould ſeeme vnproper, but howſoeuer.

For a right Horizon where the pole is in the Zenith, which I call a polar Horizon, the making of a Diall thereunto is eaſy: for if you devide a circle by your ſtaffe into 24 equall partes, and put a ſtile perpendicular therein, the labour is finiſhed, onely adding figures to the howres, as the common order is.

But for a Diall where the Equinoctiall is in the Zenith, worke thus.

Let the piece of platte whereon you would make this Diall be A B C D, then make choice of what breadth he ſhal be as D E, then draw the line E F parallell to D C, and in the middeſt thereof draw a line ſquirewiſe to E F, as G H, make H I the diameter of a circle, and on H as a center deſcribe a ſemicircle K I L, then take one of the quadrants as I L, and firſt protract an angle of 15 degrees as I H O, then of 30 as I H P, then of 45 deg. as I H Q, then of 60 degrees as I H R, laſtly of 75 as I H S, ſo have you devided I L into 6 equal parts: then keeping



[illegible] upon H, draw a line by S, noting where it cuts the line E F as A F, then draw a line from H by R noting where it cutteth E F as before, as at M, do ſo to Q P O, and the line E F ſhall be cut at N Z O, then from F to the line B D C draw a line parallell to I G, and that is the 7 of clocke in the morning: doe ſo from M N Z O, ſo have you the 8. 9. 10. and 11. of clocke as in the figure, then the howres afternoone as 1. 2. 3. &c. be all one with the forenone howres, as is plaine.

Now for the cocke of this Diall, he muſt ſtand over I G the 12 of clocke line, containing the iuſt height of the ſemidiame-

ter

ter L H, as you may well perceiue by the cocke in the Diall, which is ſhadowed with lines: for your better vnderſtanding he muſt ſtand perpendicular vpon the platte, and thus ſerue al direct Dials.

Chap. XXXVII.

To take the declination of any wall.

A Declining wall is ſuch a ſur-face that doth not directly behold the South or North, but bendeth either into the Eaſt or Weſt, and is thus found.

Draw a line perpendicular vpon the wall, and in that line ſticke a ſtile to make right angles with the ſaid wall, note when the ſhadow that ỹ ſtile yeeldeth is in one line with the perpendicular, and in that inſtance take the height of the Sunne, and ſo get by the 26 or 28 Chapter his Azimuth, reckoned from the South, for that is the true declination of the wall.

Otherwiſe.

You ſhall firſt by ſome of the forenamed Chapters get the true Azimuth of the Sunne reckoned from the South, and conſider whether it be Eaſt or Weſt, then whether the wall be Eaſt or Weſt declining from the South; firſt therefore in Eaſt declining walles open the legges vnto a right angle, and apply the right legge (the equall diuiſions vpward) vnto the ſaide wall; then if the ſhadow of the left ſight, agrée with the fiduciall edge of the left legge, the Azimuth of the Sunne is the declination of the wall; but if the ſhadow doe not agrée, then open or cloſe the left legge vntill the ſaid ſhadow do agrée, and note the quantity of the angle vpon the legs, and then worke thus.

1 If ỹ angle excéed 90, ſubtract 90, and note the remainder.

If the angle be leſſe than 90, take the ſaid angle out of 90, and note the remainder.

1 If the angle excéed 90, and the Sunne be Eaſt from the Meridian, then take the foreſaid remainder out of the Sunnes Azimuth, the remainder is the declination.

2 If the angle be leſſe than 90, and the Sunne Weſt from the Meridian, then take the Azimuth out of the foreſaid remainder, and that which remaineth is your declination.

3 If the angle be leſſe then 90, and the Sunne Eaſt, then adde the ſaid remainder to the Azimuth, ſo haue you the de-

clination: and theſe rules be generall for any South wall declining into the Eaſt.

For walles declining into the Weſt.

For Weſt walles apply the left legge to the wall, and the right as before the left.

Firſt then, if the angle be more then 90, and the Azimuth Weſt, take the foreſaid remainder out of the Azimuth.

If the angle be leſſe then 90, and the Sunne Eaſt from the Meridian, take the Azimuth out of the remainder.

But if the Azimuth be Weſt, and the angle leſſe then 90, adde the ſaid remainder to the Azimuth of the Sunne: ſo in all theſe waies haue you the declination of any South wall declining into the Weſt.

Note for Eaſt declining walles betimes in the morning, is good for Weſt late neere Sunne ſet.

Example.

I was to obſerue the declination of a wall, bending into the Eaſt, I therefore tooke the Azimuth of the Sunne, and found it Eaſt from the Meridian 16 deg. then did I apply the right legge vnto the wall as before, and found the angle 110 deg. I take therefore 90 from 110, ſo is the remainder 20, which I take from 30, and that which remaineth is 10, the declination from the wall, by the firſt def. of Eaſt walles.

Otherwiſe without the Sunne.

Conſider if the Sunne decline into the Eaſt or Weſt.

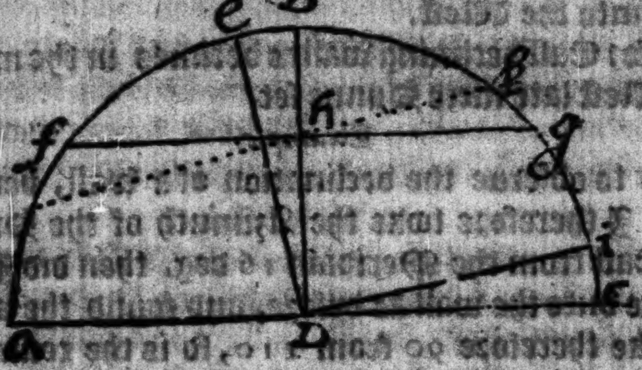
If Eaſt, apply an needle vnto the left leg as in the 28 Chap. then apply the right legge vnto the wall, opening the left vntill the needle ſtand iuſt ouer the line in the bottome of the card: then note the quantity of the angle vpon the legges for the declination.

But if the wall decline Weſt, apply the needle as before vnto the right legge, then apply the left vnto the wall, opening the right vntill the needle ſtand ouer his due place, the angle then vpon the legges is the true declination.

Chap. XXXVIII.

To learne the Eleuation and Angle of deflection, of any declining wall, by the declination.

Draw a ſemicircle A B C, then on the center D erect a perpendicular D B, then note the declination of the wall, which by the laſt Chapter was 10, therefore from B protract a chord B E of 10 deg. & from E to D draw a line E D: then note your latitude which taken from 90, the latitude is 53, which taken from 90 leaueth 37: therefore by the 6 draw a parallell to A C 37 degrees diſtant as F G, next draw a line ſo farre from C as E is from B, as I D: now I ſay, the Ellipticall line paſſing by H, counted from E D, is the angle of deflection, which by the 5 is aboute 9 degrees. I could not iudge preciſely for want of an inſtrument, when I wrote this Chap. then by the 3 Chap. the diſtance of H from D I is the eleuation of the wall, as I K,



which by the 6 you ſhall find neere 36 deg. or thereabouts. I cannot ſpeake preciſely, becauſe as I haue ſaid I wante my inſtrument.

If you deſire the ground of this worke, you may reade M. Blagraues 6 Booke, Chap. 16 of his worthy Iewell: for A C is the Equinoctiall, B D halfe the arctick line, E D the Zenith line, D I part of the Horizon.

Chap. XXXIX.

To take the reclination or inclination of any wall.

If the wall recline, apply the left legge to lie parallell with the ſuperficies of the reclining platte, then heaue up the right leg, untill he ſtand perpendicular, which you may eaſily try by helpe of a plumbe: note the angle then upon the legs, for the quantity of the reclination.

The like muſt you obſerue for inclining walles, onely the right legge muſt hang right downeward towards the ground, which before did ſtand perpendicular pointing to the Zenith.

Chap. XL.

To make a Diall to a South or North inclining or reclining flatte.

YOu muſt conſider, whether the flatte doe recline or incline, and thereby whether it be North or South: if the flatte incline or recline North, take the reclination from the eleuation: but if it be Southwards, adde the reclination to the eleuation, ſo haue you the height of the pole aboue that flatte: but if the addition exceed 90, ſubtract 90: the remainder taken from 90, leaueth the poles eleuation, which had, by the 31 Chapter make a Diall according to the eleuation, which ſhall ſerue your flatte.

At this time I will ſpeake no more of Dials, becauſe I haue drawne them into a faire volume by them ſelues, keeping it for one of my Mathematicall Flowers, where they be performed diuers waies, as well inſtrumentally and Arithmetically, as by an eaſy kind of Mechanicall working: for here my intent was not to enter into the whole Art of Dialling, but onely to ſhew you ſome ſuch few propoſitions, that the ſtaffe eaſily performed of himſelfe.

Chap. XLI.

Certaine Coſmographicall notes.

I mind not here to make ample relation of Coſmography, but onely teach you one or two concluſions: for the better vnderſtanding whereof, it were fit that theſe notes were preciſely conſidered.

1 All places according as they be ſituate vpon ẏ earth, haue both longitude and latitude, as the ſtarres haue in heauen, I ſpeake Coſmographically: and ſo is the earth diſtinguiſhed into like circles as the heauen is.

2 Latitude on ẏ earth is no other thing then declination in the heauens, therefore by the 1. def. 6, all circles of latitude lie parallell to the Equinoctiall.

3 Latitude is denominated by the arke of the Meridian or circle of longitude included betwixt the Equinoctiall and the place propoſed, ſo that there is both North & South latitude.

4 Def. North latitude is reckoned from the Equinoctiall towards the North pole, and South towards the South pole.

5 Longitude on the earth, is not taken as Longitude in the heauens, according to the 15 def. of the 1. but longitude of the earth is the diſtance of any place Eaſt from the Ilands called Inſulæ Fortunatæ, which are certaine Ilands ſituated Weſt from vs at London.

6 The Meridian paſſing by thoſe Ilands is the firſt deg. of longitude reckoned vpon the Equinoctiall into the Eaſt, ſo that there is both Eaſt and Weſt longitude.

7 Eaſt longitude continues vntill 180 deg. and Weſt longitude, from 180 vnto 360 compleate.

8 The number of Meridians included betwixt any two places reckoned on the Equinoctiall, is called the difference of longitude.

9 Our late Coſmographers make the firſt degree of longitude to take beginning at the Ilands of Azores, which is 5 deg. more Weſt then the fortunate Ilands, becauſe then the compaſſe is found to haue no variation.

10 All townes either haue one longitude, and onely differ in latitude, or one latitude differing in longitude, or elſe differing both in longitude and latitude.

11 The earth is alſo deuided by the waters after 4 manners, either it is deuided into an Iland, or a Peninſula, or an Iſthmus, or a Continent.

12 An Iland is a part of the earth that is incloſed round with waters, as Britannia, Rhodus, Scilia, America, &c.

13 Peninſula called Cherſoneſus, is neither an abſolute Iland nor yet a Continent, and is ſuch a one that is included round with waters, onely ſome narrow or ſtreight place remaining, ſuch is Cymbrica Cherſoneſus, or England and Scotland.

14 Iſthmus, is a narrow place of land included betwixt 2 ſeas, ſtretching it ſelfe ſo out, that you may paſſe thereby into the Peninſula, as an appendix, knitting the 2 Peninſulaes together, as Northumberland doth England and Scotland; ſo may you paſſe from Dania to Cymbrus.

15 A Continent is called all the fixed or ſolide earth, which is neither Iland, Peninſula, Iſthmus, but doth onely cohere and conſiſt of it ſelfe, ſuch is Bohemia, Saxonia &c.

Note the men inhabiting in theſe diuers parts the of earth, haue diuers names according to their ſhadowes, as Amphiſcij, Heteroſcij, Periſcij, and according to the ſituation, as Antæci, Periæci and Antipodes.

16 Amphiſcij, be thoſe that remaine vnder the Equinoctiall, to whom the Sunne yeeldeth 2 ſhadowes.

17 Heteroſcij, be thoſe that dwell vnder either of the temperate Zones, caſting their ſhadowes but one way at noonetide alwaies

18 Periſcij, be thoſe that caſt their ſhadowes round about, and ſuch inhabit vnder the poles, according to ſituation.

19 Antæci or Anticolæ, be ſuch that inhabite vnder one Meridian, and be a like diſtance from the Equinoctiall, that is, hauing equall latitude but on different ſides the Equinoctiall, as if ours be North, theirs is South, and they haue paria tempora, but not pariter.

20 Periæci or Circumcolæ, be they that remaine all vnder 1 Meridian & in 1 latitude, with whom there is all things alike to vs, as times, ſeaſons, &c. onely this difference, when we haue noone, they haue midnight, when we haue night they haue day, our Sunne ſet is there Sunne riſing &c.

21 Antipodes be thoſe that dwell feete to feete with vs diametrically, ſo that if there be a plumbe let fall through the center of the earth from vs, it ſhould paſſe to them.

Chap. XLIII.

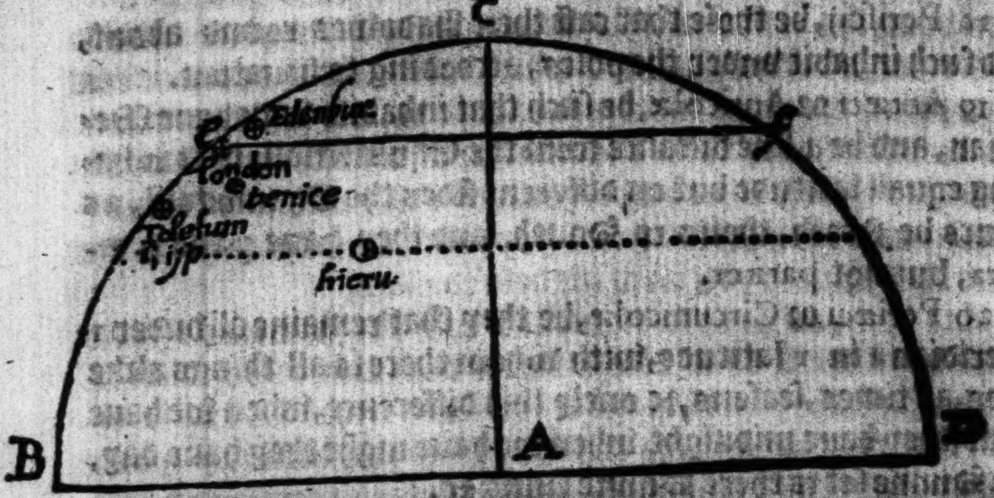
To make a mappe of the world, and therein to deſcribe any ſtation according vnto his true longitude and latitude.

This matter is very eaſily performed by your ſtaffe, firſt you muſt repaire to the tables of Apian, or ſome more late writers, and therein ſeeke the true longitude and latitude of the towne or city whoſe place you require, then draw a parallell vnto the Equinoctiall according vnto the latitude, and then where the Meridian or circle of longitude cutteth the ſaid parallell, ſo that is the place of the towne or city.

Example.

I would place London in the hemiſpheare according to true longitude and latitude, by Apians Tables I find the latitude of London to containe 52 ½ degrees, which is more then we allow, and the longitude to containe 23 ½ degr. (which is leſſe then we allow) I make A B C D an hemiſpheare, B D the Equinoctiall, C the North pole: then I protract by the 6, a parallel E F 52 ½ degrees diſtant from A D: now I make the circumference.

ference to be the firſt Meridian according to the old writers, then doe I find by the 4. where the 13 $\frac{1}{4}$ Meridian doth cut E F counted from the circumference, which falleth at E the true place of London, as you may perceiue in the figure.



In like manner may you ſee Edenburgh, Venice, and Toletum, &c. placed.

Now if you deſire hereafter by your ſtaffe to ſeeke the longitude of any place, the 5 Chapter will teach you, and for latitudes the 6 may ſuffice.

By this inſtrument may you moſt eaſily find out the diſtance of places by a ſemicircle, according as Maiſter Blundiuell hath ſet it downe, without the deuiding of the ſame into 180 degr.

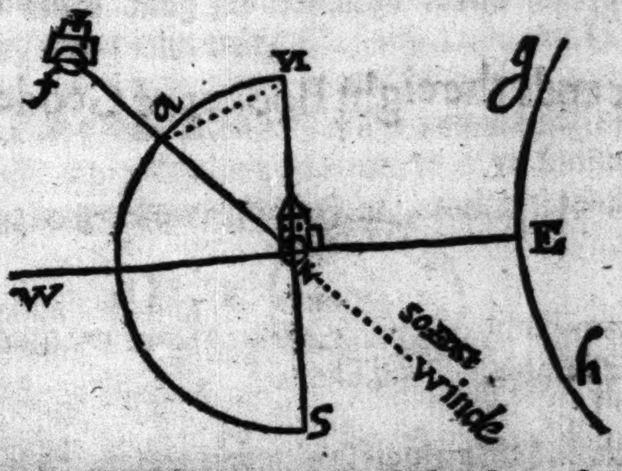
Chap. XLIII.

How to know, how one place beareth from another, by the Geodeticall ſtaffe.

The places being giuen which you deſire, to know how the one beareth from the other, you ſhall firſt take the place of your abode, which is the place you deſire to know how the other beareth from it: then in your mappe finde the next Meridian paſſing by the ſame, which had, let fall a perpendicular from the ſaid place of your abode vpon the ſaid neereſt Meridian: then croſſe the perpendicular with a line at right angles, in the very place of your abode, which ſhall repreſent the Meridian of the ſaide place, and the perpendicular the latitude, ſo the one end of the Meridian repreſenteth the North, the other the South, and the perpendicular on the Eaſt ſide the Meridian the Eaſt, and the part on ths other ſide the Weſt: now you are to conſider on which ſide this new found Meridian the other place ſtandeth either Eaſt or Weſt, and towards the ſame draw a demicircle, the one foote of your compaſſe placed in the very interſection of the lines upon ẏ place of your aboad; then upon the center of this demicircle and the place deſired lay a ruler, or extend a thred, which ſhall cut the demicircle in ſome point, the chord whereof included betwixt that point and the Meridian, doth ſhew the number of degrées; and ſo by allowing 11 ¼ deg. to a rombe, you may eaſily find what wind ẏ ſection made in the demicircle, ẏ oppoſite wind thereunto is the wind that driueth you unto the deſired place.

And here you haue to note, whether the demicircle were made upon the Eaſt or Weſt ſide the new found Meridian, if on the Eaſt the partes of the compaſſe be either S E or Northeaſt, and the contrary for the Weſt: if you deſire to worke this propoſition by this ſtaffe, you may haue the wind diſtinguiſhed upon the legges among the chord diuiſions.

Example.



GH, is the Meridian in the Map, C the place of your abode, C I the line falling perpendicular upon the Meridan, F ẏ place ſought how it beareth from C, lying Weſtwards from ẏ Meridian, N S, S W N, ẏ ſemicircle drawne on the Weſt ſide, F C a line drawn from the one place to ẏ other A, a place wher ẏ line cutteth the ſemicircle A N, the chord meaſured 45 deg. diſtant from N the North, to ẏ Weſt: now A N, 45 deg. reduced into winds, containes 4 windes from the North, which is Northweſt, and ſo doth F beare from C; now the oppoſitewind to N

W, is SE, which is the wind muſt driue you from C to F.

I might here adioyne many pleaſant & eaſy waies by this inſtrument to get the eleuation, as by the declination, almicanter, and Azimuth, or by the declination howre, and almicanter, or by the declination and amplitude, or by the ſtarres that neuer ſet, or by the ſtarres that ſet, &c. but ſince I haue ſhewed ſome few waies to that purpoſe before, I wil here leaue to confound yͤ reader with varieties, preſuming that what is ſaid before, may giue light ſufficient to the performing of theſe and many other waies.

Here ends the eight Bookes of Geodetia.

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A brieſe Table of all the Chapters, in theſe eight bookes of the Geodeticall ſtaffe.

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1 OF the framing, compoſing, and quantity of timber required to make the Geodeticall ſtaffe. Fol. 1
2 Of the deffinition and vocation of the ſtaffe and his principall partes. 3
3 Of the deuiſion of the vpſide of both the legges, together with the one ſide of the graduator. 5
4 To proiect the degree of a circle to 90 vpon the graduator, and vnto 180, vpon the legges. 6
5 The order of proiecting the Geometrical quadrant and hypſometricall ſcale vpon the graduator. 8
6 Of the ſtaffe his parts and application. 9
7 A needfull propoſition to be vnderſtood for the performing of the fourth propoſition. 13
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6 To open the legges vnto any angle propoſed. 28
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8 The altitude of the Sunne being giuen, to find the howre of the day eaſily. Ibid
9 To take the diſtance betwixt any ſtarres vnknowen. 31
10 To finde the howre of Sunne riſing, &c. Ibid
11 To finde the altitude of the North-pole, by the ſtars as neuer ſet. Ibid
12 To performe the laſt Chapter by the ſtarres as ſet, or by the Sunne. Ibid
13 The latitude of any place giuen, to get the declination of the Sun, or any planet, ſtarre &c. ſeene in the heauens. Ibid
14 Of the Anomality in the ſituation of proportionall tryangles in the legges of the ſtaffe. 34
15 A caſtle, fort, &c. ſeene, to get the true diſtance thereof, without arithemeticall calculation, Ibid
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21 A caſtell, &c. ſeene before you, ſo that by reaſon of impediments you cannot get his diſtance from you, as in the 15, how to performe it here at 2 ſtations, &c. 41
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